Study expands SA knowledge of agricultural non-point source pollution

All human activities have an impact on water resources. In a water scarce country such as South Africa it is particularly important that all impacts, particularly those that impair water quality, are recognised and managed. A recently published study funded by the Water Research Commission (WRC) has improved understanding of non-point source pollution from agricultural activities. Article by Lani van Vuuren.

Some kinds of pollution are much easier to identify, measure and control than others. When one is dealing with a sewage spill or dumped chemicals the source and effect of pollution is fairly straightforward. The same cannot be said for fertiliser or pesticides leaching slowly from an irrigated field into the soil. This is but one example of the non-point sources of pollution that a recently published multiyear, multidisciplinary WRC study aimed to understand.

As project leader, Prof André Görgens, from Aurecon explains, agriculture has been identified as a significant source of non-point source pollution. "Non-point source pollution impacts from agricultural activities include salinisation (through irrigation return flows or salt wash off and leaching under dry land cultivation), eutrophication (through fertiliser leaching and nutrient wash-off from human settlements on farms), sediments (as a result of erosion), pathogens (from intensive animal production), pesticides (through the application of insecticides, fungicides and herbicides), and heavy metals."

Unfortunately, it seems that non-point source pollution is getting worse, reports Prof Görgens. "The severe deterioration in wastewater treatment by many local authorities across the country during the past 15 years has led to high nutrient (point-source) loads in many river systems. This sometimes shrouds the nutrient loadings from crop cultivation and dense settlements. We need to take care that this phenomenon does not undermine the much-needed focus on dealing with agricultural non-point source pollution."

First order estimates were made of nutrients, sediments and pesticides in South Africa's water resources during an initial scoping study funded by the WRC in 2005. "It was recognised that more detailed research was required to measure and model the impact of this type of pollution from field to catchment scale," reports Dr Gerhard Backeberg, WRC Executive Manager: Water Utilisation in Agriculture.

This led to the latest study being funded by the Commission, the primary objective of which was to develop an integrated modelling approach to predict agricultural non-point source pollution from field- to catchment-scale for selected

non-point source pollutants. A secondary aim was to develop a modelling approach to examine the economic-environmental trade-offs of agricultural pollution control measures.

The project, which ran for close on seven years, brought together the best available experts from different organisations into one research team. As Dr Backeberg points out, apart from involving specialists in various scientific disciplines, the project also enabled interaction between natural and economic scientists. Nine different institutions and organisations were represented, namely the universities of Pretoria, Free State, KwaZulu-Natal and the Western Cape, as well as the Agricultural Research Council, CSIR, SA Sugar Research Institute, CSIRO (Australia) and Aurecon.

Prof Görgens reports that there are several challenges in South Africa hampering the effective management of agricultural non-point pollution, some of which the project aimed to address. These include inadequate understanding of the economic-environmental trade-offs of non-point source control measures; lack of practical demonstration of the water quality improvements brought about by non-point source control measures; fragmented buy-in by organised agricultural and affected farmers; administrative and regulatory disjuncture between relevant government departments and institutions (both national and provincial) as well as disjuncture between political imperatives and environmental management necessities.

The project was structured into four parallel, but overlapping, phases to ensure research effort synergies and inter-linked research output:

- Phase 1: Observation and monitoring of non-point source pollution processes at point-, field- and catchment-scales (nutrients, sediments and pesticides);
- Phase 2: Developing field-scale non-point source pollution predictive capability via a bio-physical field-scale model (nutrients and sediments), as well as an expert system (pesticides);
- Phase 3: Developing catchment-scale non-point source pollution predictive capability via catchment-scale biophysical models (nutrients and sediments); and
- Phase 4: Developing economic-environmental trade-off modelling ability, supported by the above biophysical models.

The project demonstrated that combining economic and applied natural sciences in long-term, multi-scale, multidisciplinary research is not only operationally feasible, but also yields notable scientific and technological returns. Apart from numerous cross-disciplinary research process learnings various multiscale and multidisciplinary management decision-support and planning analysis modelling tools were established.

Significant new knowledge has been generated on the identification, monitoring and management of non-point source pollution from agricultural sources in South Africa. "The project allows differentiation between non-point source and point source contributions to the general loadings in river systems; it facilitates prioritisation of non-point source control measures at both field- and catchment-scales; and it highlights the interface between economic considerations and biophysical considerations in water resource quality management," says Prof Görgens.

With publication of the set of five scientific reports, efforts will now be made to disseminate the results and findings to farmers and officials through information sessions. This will be followed by workshops to determine further actions by various stakeholders. Project members have also presented their findings at numerous conferences and through 15 journal articles.

In addition, the WRC has initiated a follow-up project on the contribution of agricultural activities to pollution of water resources with chemicals contained in pesticides and weedicides in crop cultivation and medicines for livestock husbandry, Dr Backeberg reports. "Attention is given to the impact of these waterborne chemicals on health and the ecology and the extent to which this can be traced to agricultural activities."

It is anticipated that these efforts will further contribute to sustainable agricultural production while protecting the surrounding environment.

Reports from this research

- *Modelling agricultural NPS pollution and economic-environmental trade-offs of pollution control measures. A project overview* (**Report No. TT 516/12**)
- *Modelling nitrogen and phosphorus dynamics in cropping systems at the field scale* (**Report No. 1516/1/12**)
- *Modelling the fate of pesticides: primary processes, non-point source data collection and guidelines* (**Report No. 1516/2/12**)
- *Modelling nutrient and sediment dynamics at the catchment scale* (**Report No. 1516/3/12**)
- *Modelling economic-environmental trade-offs of agricultural non-point source pollution control measures* (**Report No. 1516/4/12**) ❑