Weeding out Water Wastage in Irrigation Canals

Aquatic weeds continue to choke many of South Africa's irrigation canals and are among the main reasons why many schemes continue to remain water inefficient.

The largest consumer of water in South Africa, agriculture uses approximately 62% of the total national water supply to irrigate crops. At present, a million hectares from a potential 1,4 million hectares is under irrigation. South Africa has thousands of kilometres of canals criss-crossing the countryside from which the majority of the irrigation schemes receive their water supply. These canals are both lined and earthen structures.

Many of these water conveyance structures are plagued by aquatic weeds, such as filamentous algae and aquatic macrophytes. Following the winter months, the increasing day length and consequent rise in ambient temperatures result in increased water temperature and light penetration into water bodies. Optimum environmental conditions, and the presence of sufficient plant nutrients (phosphates and nitrates) – usually the result of pollution – lead to an increase in aquatic weed biomass of affected irrigation canals.

Envirokonsult Director, Kobus du Plessis, who has studied this phenomenon over the years, reports that aquatic weeds proliferate in a relatively short period to form dense masses of organic material that result in substantial operational problems with economic implications in water supply systems. "Large volumes of the design capacity of canals and other water conveyance structures are displaced by plant biomass."

It is estimated that a minimum of 20% to 30% of the water supplied to the irrigation sector is lost due to leakages out of conveyance structures, evaporation, evapotranspiration, spillage and flooding, among others. Some older schemes have, and still are, recording periodic losses of up to 70%. As aquatic weeds contribute significantly to these water losses this problem is also addressed by the Department of Water Affairs and Forestry's Water Conservation and Water Demand Management Strategy.

"Based on current agricultural tariffs, a mere 10% saving in the current water loss (taken as 25% of usage by the agricultural sector), can result in savings of at least R82-million per annum (savings on crop losses not included) and release more than 500 million m^3 of water for use by other sectors," notes Du Plessis.

OPERATIONAL PROBLEMS

Aquatic weeds cause a host of operational problems in water conveyance structures, such as reducing hydraulic capacity and flow speed in affected canals – some to such a degree that the supplied water cannot reach the terminal point of the canal system. Aquatic weeds can replace significant volumes of the capacity of a canal. This results in overflows that may contribute to losses out of the system, as well as crop losses due to under-supply of water to irrigators.

Another problem is that of overestimation of the volume of water supplied to the user. As aquatic weed biomass replaces water in a canal, a higher volume of water is measured at measuring devices at what is in fact passing at that specific location. This overestimation of flow makes the optimal operation of water supply a difficult task as less water is passing at a specific point as what is measured. To compensate for these artificially high water levels, more water is often released into the system, giving rise to flooding and subsequent water loss.

Other problems include impediment of sluice gates working at dividing structures, water logging of long-weirs, structure failure of concrete-lined irrigation canals due to flooding, and blocking of irrigation systems and filters at water purification works by aquatic weed fragments.

CONTROLLING AQUATIC WEEDS

Historically, aquatic weed control measures applied in South Africa have been symptomatically orientated. The problem is thus treated only once it visibly influences the operation of the system. Different control options have been investigated over the years and implemented with varying levels of success. One of the greatest challenges is finding an option that takes the canal out of operation for as short a time as possible.

Mechanical removal has been a popular method, however, it is expensive and labour intensive. It has also been found that in peak summer months the biomass cannot be removed efficiently. "To date, attempts to control the biomass mechanically in systems that continuously supply water seem to be relatively unsuccessful and uneconomic," says Du Plessis.

In terms of chemical control methods the so-called 'lower pH method' has been favoured using mainly copper sulphate. Local herbicidal options are limited to the treatment of aquatic weeds with herbicides/algaecides with mainly copper as active ingredient, as well as a herbicide with diquat as active ingredient. Unfortunately, both substances have their limitations under local conditions. The copper products are more effective on algae than on macrophytes, while the diquat-based product is more effective on macrophytes than algae.

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Aquatic weeds are choking many of South Africa's irrigation canals severely affecting performance and water efficiency.

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Physical cleanup of aquatic weeds and algae in water conveyance structures is an expensive, labour-intensive process.

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Water loss and structural damage due to flooding can occur as a result of aquatic weeds in irrigation canals.

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Typical dosing with the water-soluble aldehyde.

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A South African irrigation canal following acrolein treatment.

Other algaecides and herbicides with heavy metals as active ingredient were also tested over the years. But the problems associated with these products were many as their usage resulted in the build up of toxic residues in irrigation soils, necessitated downtime for the canals as well as withholding periods from crops. Biological methods, such as the introduction of sterile Chinese grass carp, has also been investigated by Du Plessis's team.

LOOKING AT ALTERNATIVES

An alternative herbicide has now been introduced to the South African market from the United States. "This water-soluble aldehyde, which comes in liquid form and has acrolein as its active ingredient, can be used in operational systems without interrupting irrigation water deliveries, and is characterised by superior effectiveness and quick dissipation without any residue," reports Du Plessis.

"What makes acrolein a good prospective is that the product does not accumulate in crops, soil or groundwater and can be applied directly to crops. Furthermore, acrolein (an organic molecule) dissipates to harmless carbon dioxide and water as end products, which makes it more environmentally friendly." It is also effective on both algae and macrophytes and is used widely in the United States, Australia, Canada, and other countries with similar problems.

Scientific trials with the new product have been completed successfully in Roodeplaat and Hartbeespoort canal systems. In the case of Hartbeespoort water losses was cut by 17% and the water saved could be made available to new mines in the area which are expected to inject more than R1-billion into the local economy – something that would have been lost without the available water.

The new product is currently in the registration process. It is hoped that it will find large-scale application to remove aquatic weeds from water conveyance systems and bring about the necessary water savings to the irrigation sector.