WATER RESEARCH COMMISSION

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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.

TECHNICAL BRIEF

Water and the environment

Using remote sensing to control water hyacinth

A completed Water Research Commission (WRC) project has investigated the use of hyperspectral sensing to detect biotic and abiotic stress in water hyacinth.

Background

Water hyacinth is the most notorious aquatic weed in the world and it is known as one of the most efficient and productive plants on the planet. South Africa has released seven biocontrol agents against water hyacinth since 1974, none of which have achieved a satisfactory result to reduce the scourge compared to countries such as Uganda, Australia, Papua New Guinea and USA.

As a result, water hyacinth control in the country has shifted to integrated management, which combines the application of herbicides with biological control methods. However, this requires regular monitoring of the weed's physiological status in relation to the habitat, in order to facilitate the decision when to intervene and what intervention measures are appropriate.

Remote sensing of vegetation reflectance has the potential to be that monitoring tool.

WRC study

The WRC investigated the physiological status of water hyacinth grown with eight different heavy metals in a single-metal tub trial, three different simulated acid mine drainage (AMD) treatments in a pool trial under the influence of a biocontrol agent, and in the Vaal River at the inlets of its tributaries, the Koekemoerspruit and the Schoonspruit.

A hand-held spectrometer, the analytic spectral device, was used to measure reflectance. The hypothesis that hyperspectral remote sensing can 'see' the response of the plant to both the heavy metals and the biocontrol-induced stresses and their interactions was tested.

Study results

Using the spectral indices associated with canopy chlorophyll content, such as the modified normalised difference vegetation index (mNDVI), the linear extrapolation and the maximum first derivative methods that calculate the red edge position, and the water band index which determines the canopy water stress, the hyperspectral sensor was able to detect both the metal or AMD and weevil-induced plant stresses.

These spectral indices resulted in a strong positive correlation with the actual lead chlorophyll content, measured by a SPAD-502 chlorophyll meter, of which correlations with the mNDVI and the REP spectral indices were the greatest.

Among the contaminants Cu, Hg and Zn from the single-metal, tub trial and sulphate concentration exceeding 700 mg/ℓ in the AMD pool trial were detected by the remote sensor as stressful to the plants. These results were also consistent with the actual measurements of the different plant growth parameters and the weevils' feeding and reproductive activities in both trials.

The different growth parameters of water hyacinth showed that the plant was generally tolerant to most pollutants. Nevertheless, the few symptoms of plant stress due either to the phytotoxicity of the pollutants or feeding damage by the weevils, such as leaf chlorisis, reduction in leaf area, fresh weight of plant biomass and plant density, were detected in the remote sensing.

Similarly, the remote sensing results from the field trial showed that water hyacinth plants at the inlets of the Schoonspruit o the Vaal River grew bigger and healthier after the rain than before the rain and plants at the downstream site of the Schoonspruit inlet looked healthier than all the other sites.

The consistent effect of the three metals (Cu, Hg and Zn) in the single-metal tub trial, and the medium and high AMD concentration treatments in the simulated AMD pool trial, and the increased pollution level after the rain, particularly on the Schoonspruit site, on the weevil's plant activities and plant growth parameters with those found in remote sensing data, confirm the feasibility of using the hyperspectral remote sensing to identify both metal/AMD and weevil-induced plant stresses and accurately evaluate water hyacinth.

Thus, the results of this study indicate that hyperspectral remote sensing has potential as a tool to assess the physiological status of water hyacinth from a remote position, to therefore inform management intervention in control of the weed. However, its use at a larger scale requires further studies.

It also shows that although the general activities of the weevils decreased in response to metal pollution and AMD, the weevils nevertheless managed to cause some damage to the plants. Nevertheless, their use as biocontrol agents will be hindered by the pollutants and probably should be used synergistically with herbicides.

Further reading:
To order the report*, Hyperspectral remote sensing to detect biotic and abiotic stress in water hyacinth (Eichhornia Crassipes) (*Pontederiaceae*) (***Report No. 2037/1/13***),* contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za or Visit: www.wrc.org.za to download a free copy.