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Hyperspectral remote sensing to detect biotic and abiotic stress in water hyacinth, (Eichhornia crassipes) (pontederiaceae)

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2014-07-24
http://hdl.handle.net/10539/14997

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Abstract

Water hyacinth (*Eichhornia crassipes*) is one of the most notorious aquatic weeds in the world. Its management, despite the release of seven biocontrol agents since 1974, remains a problem in South Africa. This is often attributed to the high level of eutrophication. However, information on the effect of heavy metals or AMD on *Neochetina eichhorniae* and *N. bruchi*, which are the common and most widely established biocontrol agents in the country, is limited. In addition integrated management, which combines herbicides with biological control methods, is the current water hyacinth control method, and requires regular monitoring of the weed's health status. This can be assessed via the canopy chlorophyll and water content, and can facilitate the decision when to intervene and what intervention measures are appropriate and timely. Hyperspectral Remote sensing (HRS) has the potential to be that monitoring tool. This thesis investigates 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 biocontrol agent from *Neochetina* spp., and in the Vaal River at the inlets of its tributaries, the Koekemoerspruit and the Schoonspruit. A hand-held spectrometer, the analytic spectral device (ASD), was used to measure reflectance. The hypothesis that HRS can detect the response of the plant to both the heavy metals and the biocontrol-induced stresses and their interactions was tested.

Different spectral indices associated with the canopy chlorophyll and water content of water hyacinth were evaluated. Among these the modified normalized difference vegetation index (mNDVI) and those associated with the red edge position (the linear extrapolation and the maximum first derivative indices) were able to detect the metal, or AMD or weevil-induced plant health stresses and showed a strong positive correlation with the actual leaf chlorophyll content, measured by a SPAD-502 chlorophyll meter. Among the contaminants Cu, Hg, and Zn treatments from the single-metal tub trial and sulphate concentrations exceeding 700 mg/L in the AMD pool trial were detected by the RS as stressful to the plants. The RS also indicated that the water contamination level was greater downstream at the inlet of the Schoonspruit into the Vaal River, compared to the

other sites after rainfall. These results were also consistent with actual measurements of the different plant growth parameters in all the trials and the weevils' feeding and reproductive activities in the tub and pool trials. Thus, the results of this study indicated that the HRS has potential as a tool to assess the physiological status of water hyacinth from a remote position, which could be helpful in management of a serious national problem. The acquisition of spectral reflectance data at a larger scale, from aerial platforms, involves a complex data set with additional atmospheric interference that can mask the reflectance and which demands more complicated image analysis and interpretation. Thus, further such studies in future are recommended.