ACID MINE DRAINAGE AND PHREATOPHYTE VEGETATION: BIOGEOCHEMICAL CYCLING OF POLLUTANTS BY PHREATOPHYTE VEGETATION ON ACID MINE DRAINAGE: IMPLICATIONS FOR LAND–USE PLANNING

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Abstract

Saline waste-water disposal and acid mine drainage (AMD) from gold and uranium mining has contaminated shallow unconfined aquifers in the South African goldfields. Since phreatophytes obtain most of their water requirements from ground water, contaminants could become accumulated in the rooting-zone via transpiration, or even above-ground in foliage. This presents a potential mechanism for cleansing of AMD, but also a pollution risk to vegetation and soils.

This study describes how growth in contaminated groundwater in the Free State Province has impacted on the elemental composition of five tree species and their sub-canopy soils (*Acacia karroo, Rhus lancea, Eucalyptus sideroxylon, E. camaldulensis* and *Schinus molle*). Concentrations of major inorganic pollutants (Mg, Na, Cl, S) and some trace metals are elevated in groundwater and surface waters from the region impacted by mine waste disposal. The foliage, bark and wood of trees growing in this region, as opposed to solely agricultural lands, was found to contain higher concentrations of most of these elements, with *Eucalyptus* spp accumulating higher levels than the other species. The litter layer and topsoil below the canopies of *Eucalyptus* spp and *S. molle* trees growing on contaminated groundwater was found to be significantly enriched in the same elements accumulated by these trees. Subsequently, the distribution of gypsum and jarosite (sulphate mineral efflorescence associated with AMD in highveld soils) was mapped over an area of 420km^2 using airborne hyper-spectral remote-sensing (HSRS) in parallel with ground-based spectral and chemical measurements for ground-truthing purposes. Thematic HSRS images demonstrated that the majority of tree clumps (predominantly *Eucalyptus* spp) growing on contaminated groundwater, are associated with localized deposition of gypsum and jarosite.

The findings of the study indicate the need for land-use planning on the gold fields to take into consideration various scenarios for interactions between contaminated waters, vegetation and soils. Tree and shrub biomass is a potential sink for inorganic pollutants that could prevent AMD from moving into groundwater. In addition, this study demonstrates that stands of trees are directly abstracting contaminants from the saturated zone, and that contaminants are accumulated in the litter and sub-canopy topsoils of some species. Depending on the type and concentrations of contaminants in groundwater, the plant species present, and the receiving soils, the enrichment could lead to agricultural improvements (e.g. via gypsiferous and micronutrient amendments), or to toxicity and changes in natural vegetation composition..

Editorial Note

A paper on this subject is in preparation for publication in other scientific media. Interested readers are advised to contact the first author.