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Contaminated site remediation monitoring

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Sites contaminated with radioactive waste, mine tailings or other material can have severe impacts on both ecosystem integrity and human health. In this regard, remediation is aimed at diminishing the interaction between the concerned site and the impacted environment.

The economic impact of these sites is also highly relevant. Although policies and regulations exist to manage this particular issue, every site has unique characteristics and thus requires distinctive treatment toward remediation. Overall site management (characterization, evaluation, risk assessment, remediation, monitoring) aims to protect human health and the ecosystem. However, this is a complex and expensive issue, especially in remote or difficult to reach areas.

Tools and techniques

Well-established traditional techniques exist for addressing the issue (sampling in the field, lab analysis, data collection) but these are often limited because of cost, location and extent. Remote sensing provides an opportunity to enhance and complement these analyses. It provides regional perspective to a local source influence, as well as providing a robust and quantitative approach for key issues to site managers and enforcement agents. It also allows the potential for a long-term economic contribution to both monitoring and mitigation issues.

Like any other tool, hyperspectral remote sensing should not be used in isolation. Remote sensing provides a quantitative approach to remotely monitoring and economically managing when and where risk intervention should be investigated.

Environmental monitoring of remediation management activities researched through the hyperspectral program at the Canada Centre for Remote Sensing (CCRS) includes evaluating imaging spectrometer data (hyperspectral imagery) for characterizing environmentally contaminated sites and providing techniques to monitor their remediation. Examples of such sites include mine tailing sites and related waste disposal sites and the remediation and rehabilitation of these sites.

In one study area, hyperspectral imagery from a Compact Airborne Spectrographic Imager (*casi*) in the visible and near infrared was used to characterize sulphide mine tailings at the Copper Cliff tailing impoundment area in Sudbury, Ontario. Other example study sites have detected and mapped the distribution of tailings from uranium mining in Canada to monitor the distribution of this potential radioactive contamination in support of site remediation.

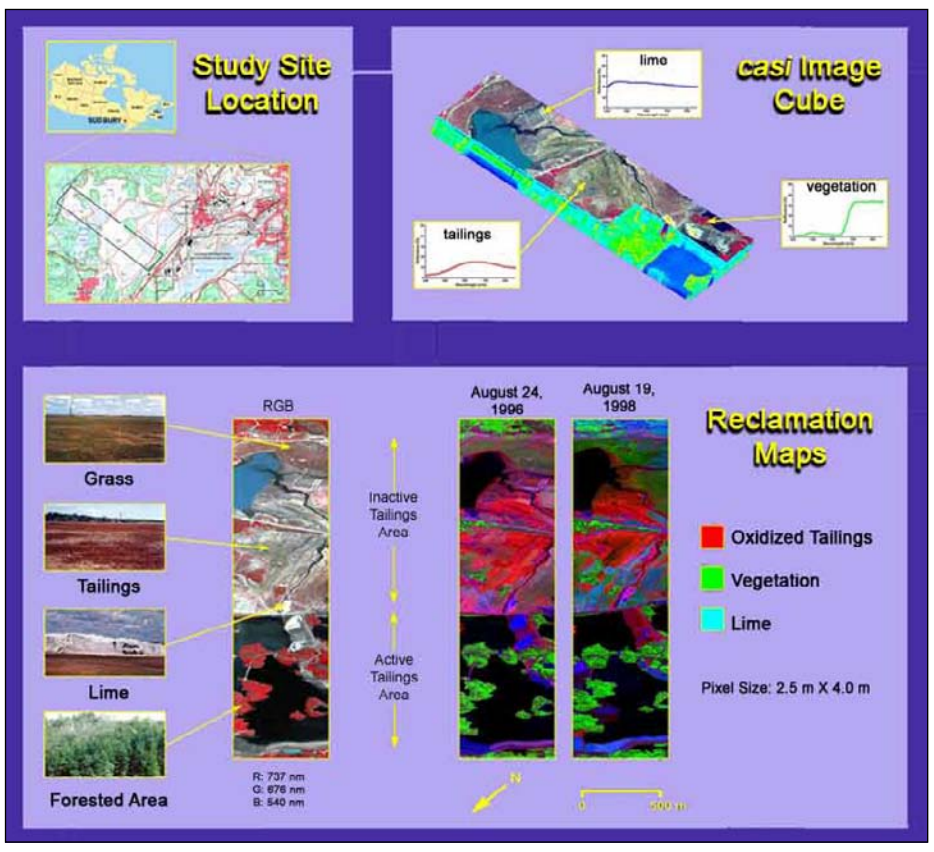

Figure 1. Monitoring mine tailings site revegetation using hyperspectral remote sensing

Figure 1 shows a study site location in Sudbury, Ontario, including a *casi* image cube of 1996 (*top right*) and reclamation maps showing the rehabilatation progress between 1996 and 1998 (*bottom*). The maps were derived with spectral unmixing. The levels of abundance range from 0 in blue to 1 in red.

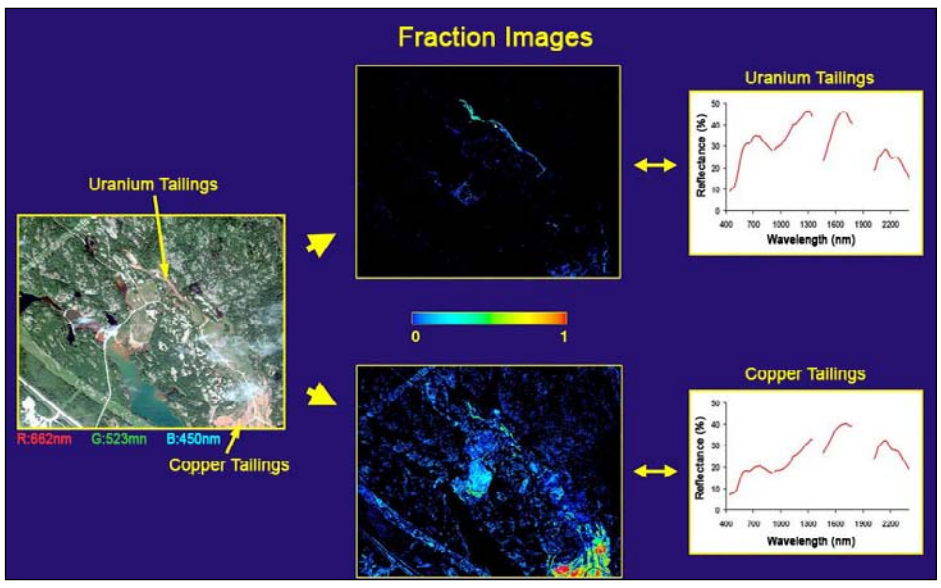

Figure 2. Discrimination of uranium and copper tailings

Figure 2 shows end member fraction images of uranium and copper tailings. High fractions are shown in white and zero fractions in black. Their associated end member spectra are shown. Both end member spectra exhibit the shape of an iron oxide mineral with the strong iron absorption band in the range of 850 to 1000 nanometres (nm).

Foundation

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Advances

One research project with collaborators Vale (formerly Vale-INCO Limited) and the City of Greater Sudbury used hyperspectral imagery. The imagery from the *casi* and Hyperion sensors in the visible and near infrared was used to characterise sulphide mine tailings at the Copper Cliff tailing impoundment area in Sudbury.

The Sudbury site was chosen primarily to monitor the results of re-vegetation efforts performed in the impacted region. Image data sets of the study sites were processed and analysed using the CCRS Imaging Spectrometer Data Analysis System (ISDAS). Results displayed here indicate that these techniques can be employed successfully to map such sites and to monitor the results of rehabilitation efforts.

More recently, CCRS has been invited to consult with the International Atomic Energy Agency (IAEA) to produce a guidance document on the use of remote sensing technologies in the assessment of remediation works of radioactive waste contaminated sites. This guidance document will be available to all IAEA member states (including Canada) to assist remediation management and the reporting of progress.

References

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