Six Ramsar remote sensing case studies were developed in 2002 as part of the NASA Socioeconomic Data and Application Center's (SEDAC) Ramsar Wetlands Data Gateway, developed in support of the Ramsar Convention on Wetlands of International Importance. That web service has been discontinued but the case studies are available from the documentation page for SEDAC's Sea Level Rise Impacts on Ramsar Wetlands of International Importance, v1 (2000–2010) data set at https://doi.org/10.7927/H4CC0XMD

South Africa: uKhahlamba Drakensberg Park and the National Wetlands Inventory

by John Dini
Assistant Director, Biodiversity Planning
Department of Environmental Affairs and Tourism
Republic of South Africa
Web: http://www.ccwr.ac.za/wetlands

I. Introduction

uKhahlamba Drakensberg Park (formerly Natal Drakensberg Park) was designated as a Ramsar site on 21 January 1997, and features 242,813 ha of high altitude tarns, springs, bogs, marshes and streams. The area is located in eastern KwaZulu-Natal, along the border between the Province of KwaZulu-Natal, South Africa and the Kingdom of Lesotho. Extensive wetlands of various types occur within the rare Afro-alpine and Afromontane belts. The Drakensberg is regarded as the most important mountain catchment in South Africa because of the high water yield and good quality water which flows from it. Marshes in the park tend to occur in permanently waterlogged areas on very gentle slopes or in depressions, and are characterized by various vegetation types dominated by Cyperaceae and, to a lesser extent, Juncaceae.

The primary reason for the establishment of the uKhahlamba Drakensberg Park was to ensure the maintenance and production of quality water for the country's needs. The South African Department of Water Affairs and Forestry have implemented a water scheme to pump water out of KwaZulu-Natal to the densely populated and highly industrialised Gauteng Province in the interior of the country. The Park attracts thousands of visitors annually both from South Africa and overseas who make use of caves, public campsites and mountain huts for overnight visits.

The original objectives for using remote sensing were to:

1. prepare an inventory of the wetlands of the uKhahlamba Drakensberg Park according to the Ramsar wetland descriptors;

2. evaluate the effectiveness of using satellite imagery as a preliminary mapping tool to determine the location, the extent, and the features or characteristics of the wetlands;
3. investigate the feasibility of classifying wetlands based on satellite imagery; and
4. develop a mapping, inventory and monitoring procedure for the wetlands of the uKhahlamba Drakensberg Park, which would be applicable on a national scale in the context of a National Wetlands Inventory.

2. Description of methods and results

The project evaluated several types of imagery, including SPOT, Russian satellite, Landsat MSS and TM imagery, and ultimately selected Landsat TM imagery from September 1991 for the analysis. Landsat TM, provides a reasonably quick and cost-effective means for mapping wetlands. In South Africa, the imagery is generally available for all areas and has a good historical archive. This allows the most appropriate images to be selected and seasonal differences to be analyzed. The repeatability of satellite-based mapping, in terms of both the availability of archived imagery and the frequency with which new imagery is acquired, makes this method well suited to on-going monitoring of wetlands.

Despite the advantages of Landsat TM, this imagery was not considered adequate for mapping the wetlands of the uKhahlamba Drakensberg Park to a high level of accuracy. As a result of the constraints imposed by the resolution of the imagery, wetlands over one hectare (100 m2) in size could be detected with 90 percent accuracy, but those under that threshold could generally not be detected. Research has shown that an object must be 54 m across before its radiance can be accurately detected, thus indicating that the minimum size of a detectable object is larger than the 30 m resolution of Landsat imagery (Townshend and Justice 1988). In these highland areas, with many seasonal and temporary marshes and hill slope seepage wetlands, there are many wetlands under the one hectare threshold. Transformed wetlands were also not consistently detected, as a result of mixed spectral signatures.

Mapping of wetlands using satellite imagery is essentially limited to a generic "presence and absence" mapping of "core" wetland areas, where the identified wetlands are primarily defined by temporal surface vegetation characteristics rather than more permanent sub-surface soil profiles. This is an important consideration in the climate of South Africa, with important seasonal and interannual precipitation variability, since in some years wetlands may be much wetter than in others. In these circumstances, the direct presence of water, surface vegetation conditions, or permanently saturated soils are often unreliable indicators of wetland conditions or boundaries, with the result that wetlands will not always exhibit obvious spectral signatures.

The proposed solution for the national wetland inventory is to combine Landsat imagery in a GIS with digital elevation model (DEM), hydrological and land use data. The final wetland delineation will be achieved by combining a DEM-derived Landscape Wetness Potential (LWP) model with the image-derived spectral wetland classification, in order to modify the spatial distribution of the spectrally defined wetlands according to terrain-defined wetness potential classes. A second model, termed the Topographic Relative Moisture Index (TRMI), is an index, which combines relative slope position, slope configuration, slope steepness and slope aspect into a single scalar value (accumulative range from 0 to 60). It will also be used to assist in identifying potential wetland areas. Both are illustrated for two wetland areas which, like uKhahlamba Drakensberg Park, are located in the highlands of KwaZulu-Natal Province (see Figure 1). Figure 2 illustrates the proposed final products, developed through a larger pilot project to develop methods for the for the national wetland inventory (Wetlands Inventory Consortium 2002).

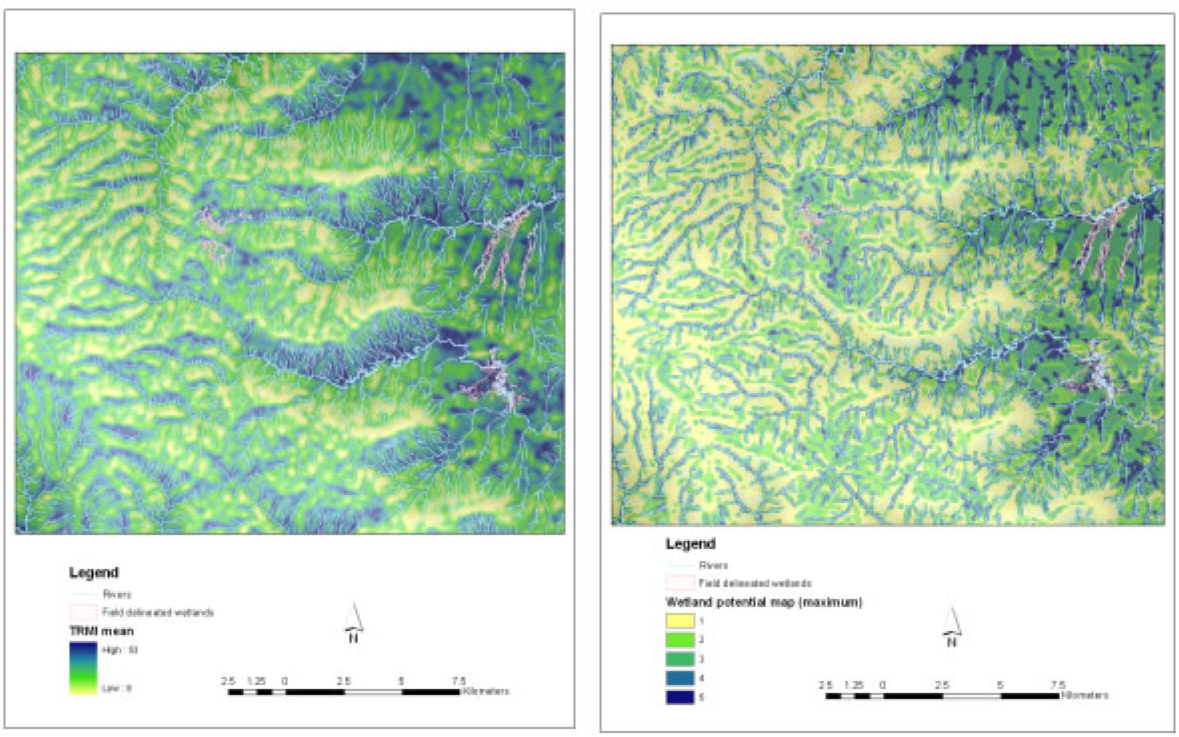

Figure 1. (a) Landscape Wetness Potential (LWP) and (b) Topographic Relative Moisture Index (TRMI) for High Moor and Kamberg study sites in Kwazulu/Natal Province. (Source: Wetlands Inventory Consortium, A Methodology Proposed for a South African National Wetland Inventory, March 2002.)

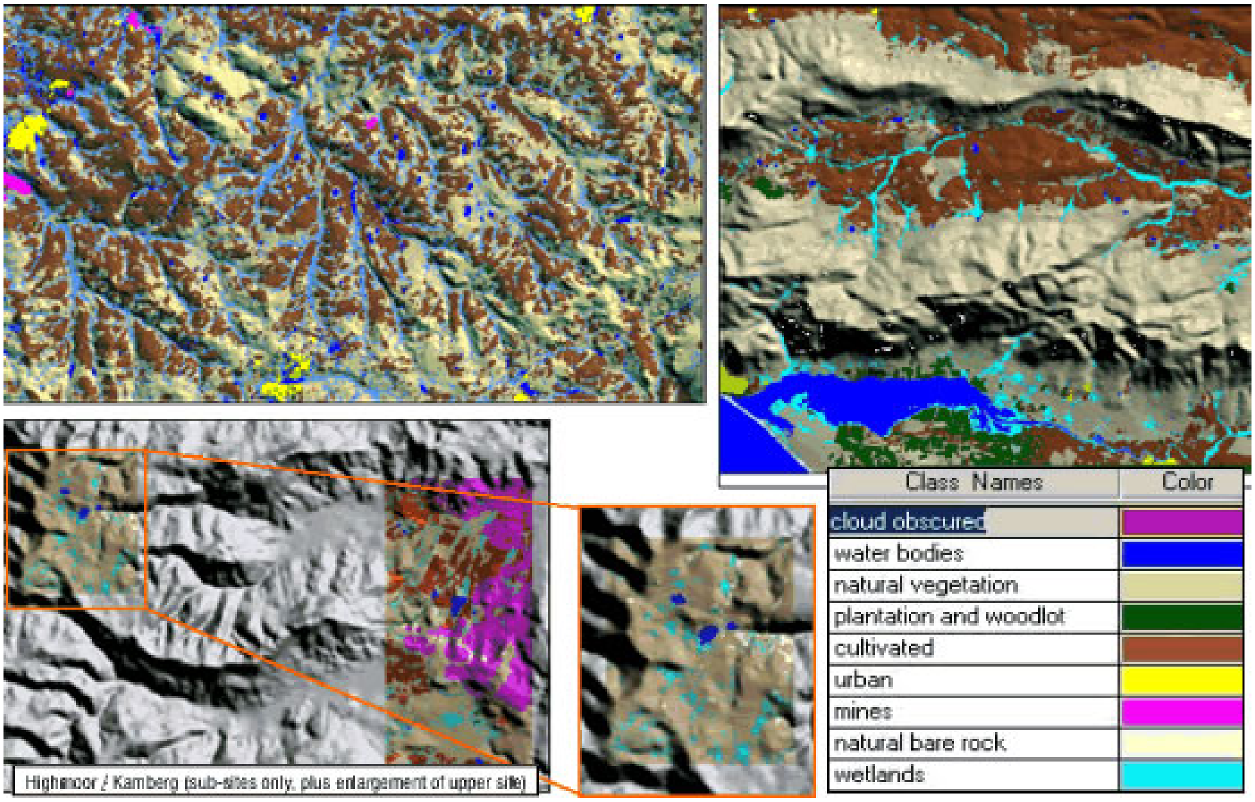

Figure 2. Final wetland classifications for Davel, Highmoor/Kamberg and Walker Bay test sites, generated using image-derived spectral classifications, modified with terrain-derived hydrological flow accumulation models (Source: Wetlands Inventory Consortium, A Methodology Proposed for a South African National Wetland Inventory, March 2002.)

3. Conclusions and next steps

This pilot effort at uKhahlamba Drakensberg Park yielded useful results in terms of testing approaches for South Africa's national wetland inventory. Based on these results, and the recommendations of the pilot project for the national wetlands inventory, a phased approach will be followed. The first stage of the inventory will be integrated into the National Land Cover 2000 project, which is a satellite-based national 1:50,000 scale baseline inventory of current land cover and land use. Although the resulting spatial wetland data will have limitations in terms of the accuracy of boundary delineations and under-representation of small and transformed wetlands, it will nonetheless provide a highly cost-effective and quick means of generating a national overview of the country's wetlands.

Subsequent phases of the inventory will utilize the spatial data generated through the National Land Cover project as a baseline from which to undertake more detailed mapping in priority catchments and Ramsar sites. It is likely that aerial photography will be utilized, in order to produce the required detail and accuracy.

4. References

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