HYDROLOGIC CHANGE ASSESSMENT - UPDATING THE NHD WITH MULTITEMPORAL IMAGERY

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ABSTRACT

In Kentucky's Eastern Coal Fields physiographic region, mining and reclamation activities often result in stream modification, potentially leading to the creation of new ponds and reservoirs. Incorporation of these changes as part of updates to the National Hydrography Dataset is proceeding slowly. The 2001-2005 Kentucky Landscape Census modernization of the NLCD01 demonstrated the extremely dynamic characteristic of the landscape in that region of the state where major land cover changes are due to resource extraction. Timely, in-situ monitoring and assessment of waterbodies created or modified in permitted mining operations would prove costly for government agencies. This paper explores the use of multitemporal change analysis, based on Landsat 5 TM and aerial, multispectral imagery for the detection of new waterbodies in areas affected by mining activities.

INTRODUCTION

Constant maintenance and update of the spatial and attribute information contained in the National Hydrography Dataset (NHD) is of critical importance to water resource managers. Water bodies in Kentucky – such as ponds and reservoirs, provide essential and diverse services to fish and wildlife, livestock, crops, industry, commerce and humans, including flood and sediment control. Inventorying these water bodies is often challenging due to the patterns of land use and ownership in the Commonwealth. Both the USGS National Land Cover Dataset (NLCD) 1992/2001 Retrofit Land Cover Change Product (LCC9201) (http://www.mrlc.gov/multizone.php); and the 2001-2005 land cover change product (LCC0105) created by the Kentucky Landscape Census Project (KLC) (http://kygeonet.ky.gov) document significant changes in number and extent of water bodies in Kentucky. Due to the dynamic nature of the changes and to access issues, inventorying of new water bodies and deletion of no longer extant features is often accomplished by delineations utilizing high resolution (e.g. aerial) imagery as photobase.

For several years now, the Landsat mission archives have been available to the public at no cost (http://landsat.usgs.gov/). The continued operation of the Landsat 5 and 7 missions counteracts the low resolution of the multispectral imagery. On the other hand, while aerial imagery acquisitions are typically carried out at much higher spatial resolution, their episodic nature poses a problem for periodic monitoring of resource change (Frazier and Page, 2000). Previous work indicated that the "wetness" band of the tasseled-cap transformationon TM Landsat 5 data could be of use in the analysis and feature extraction processes (Figure 1) (Crist et al., 1986).

METHOD AND RESULTS

Landsat 5 TM scenes, 2009 epoch (leaf-off) and high resolution aerial imagery (leaf-off, 1990s, leaf-on, 2008) were used to detect and photo-verify both pre-existing, and new but unmapped bodies of water in counties from the Eastern Coal Fields physiographic region. Water bodies and area features contained in the Kentucky portion of the NHD (http://nhd.usgs.gov) (downloaded January 2010) were used as a mask to calculate pixel-based statistical measures for the wetness values (Figures 2, 3 and 4).

By using a threshold wetness band value as an indicator of open water (i.e. water bodies), a preliminary analysis yielded features not present in the NHD, with areas between slightly less than 1 Ha to almost 17 Ha, distributed in eight counties (Figure 5).

This method, however, failed to detect smaller features and also yielded some false positives due to snow ground cover, water ponding, clouds and cloud shadows. Based on preliminary evidence, it seems a technique including tassel-cap transform and other spectral enhancements of low resolution – but current – imagery from Landsat 5 or 7 could guide the discovery and inventorying of features, concomitantly assisting with a timely update of the NHD.

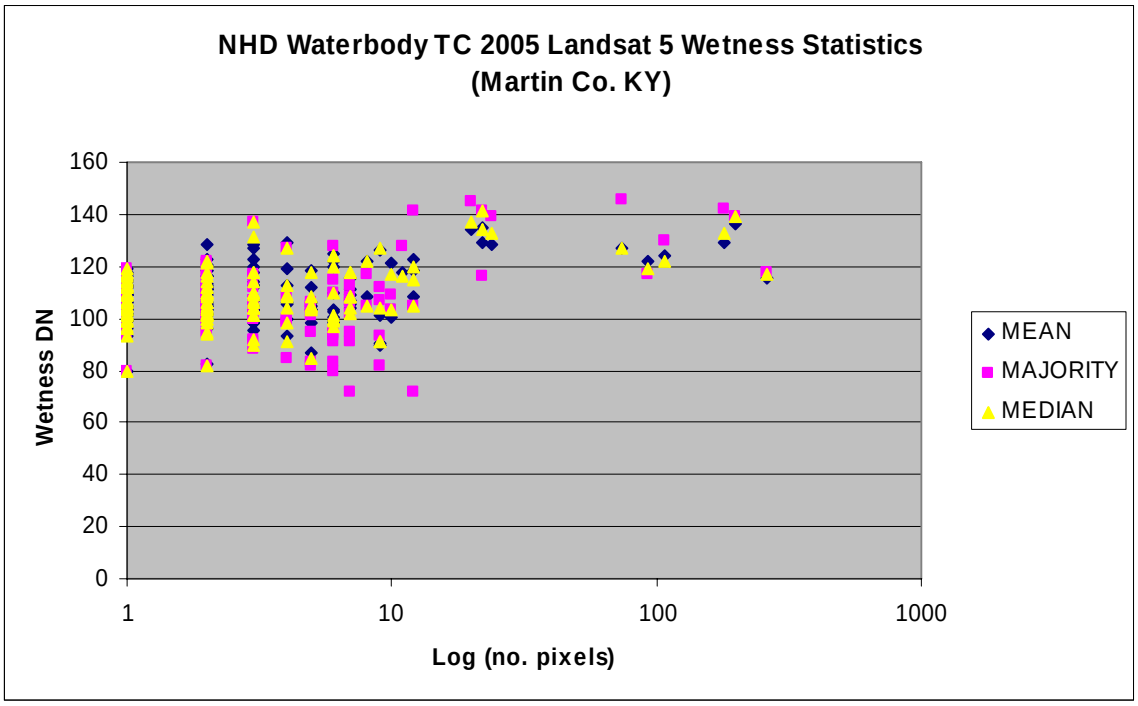

Figure 1. Wetness band statistics for NHD water bodies (Landsat 5 TM, 2005 epoch).

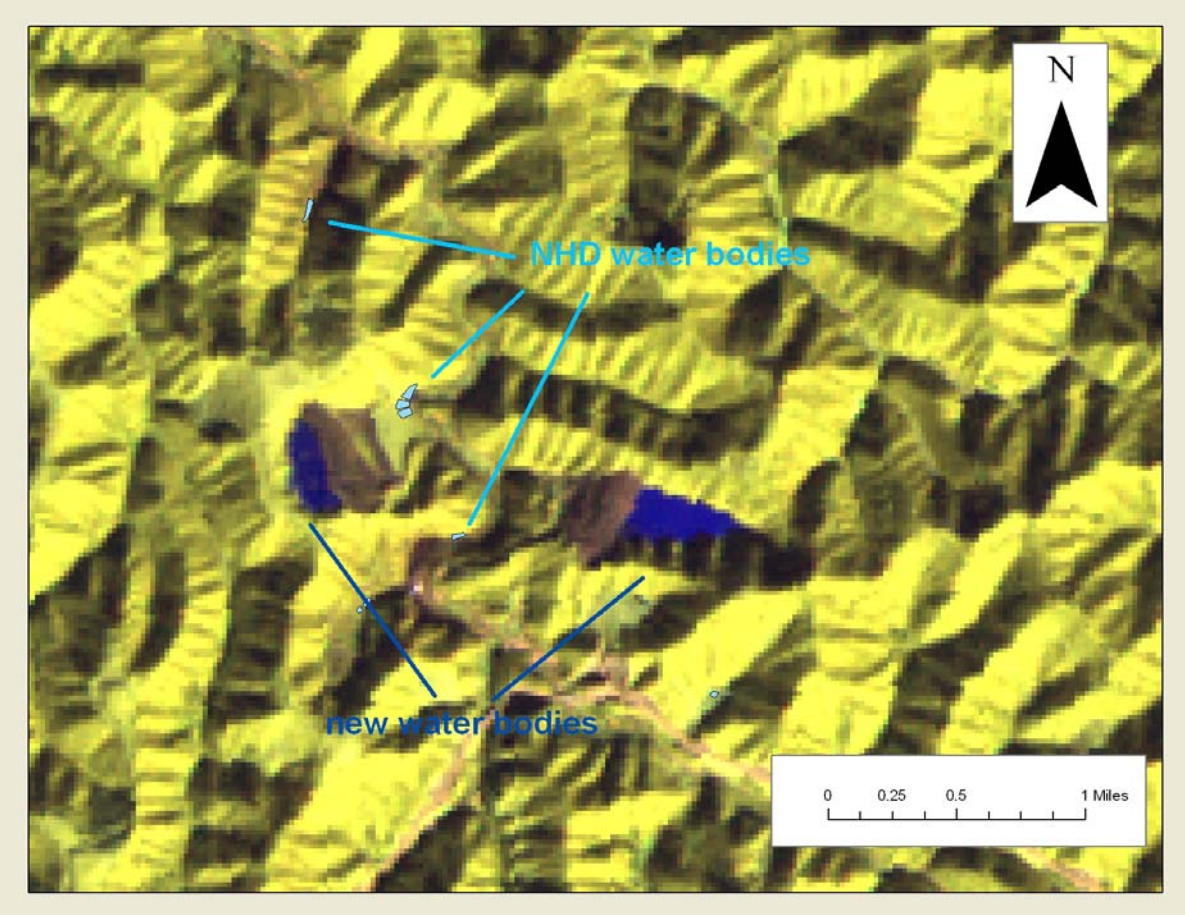

Figure 2. Water body features present and absent in NHD; Landsat 5 TM scene (acquired February 2009; path 19-row 34); RGB= bands 6, 5 and 3.

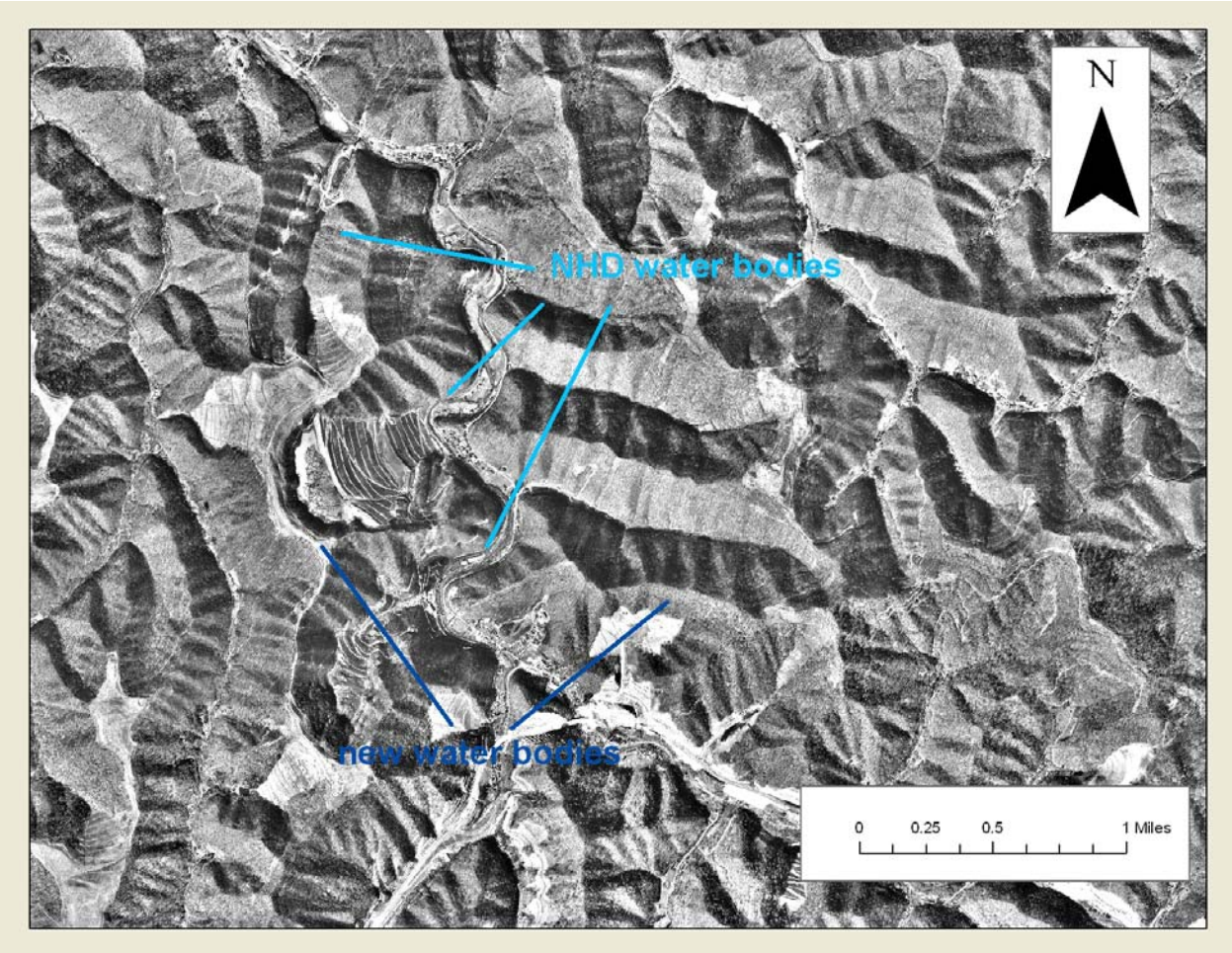

Figure 3. Water body features present and absent in NHD; aerial orthophoto (acquired late 1990s, leaf-off, 1 m ground resolution).

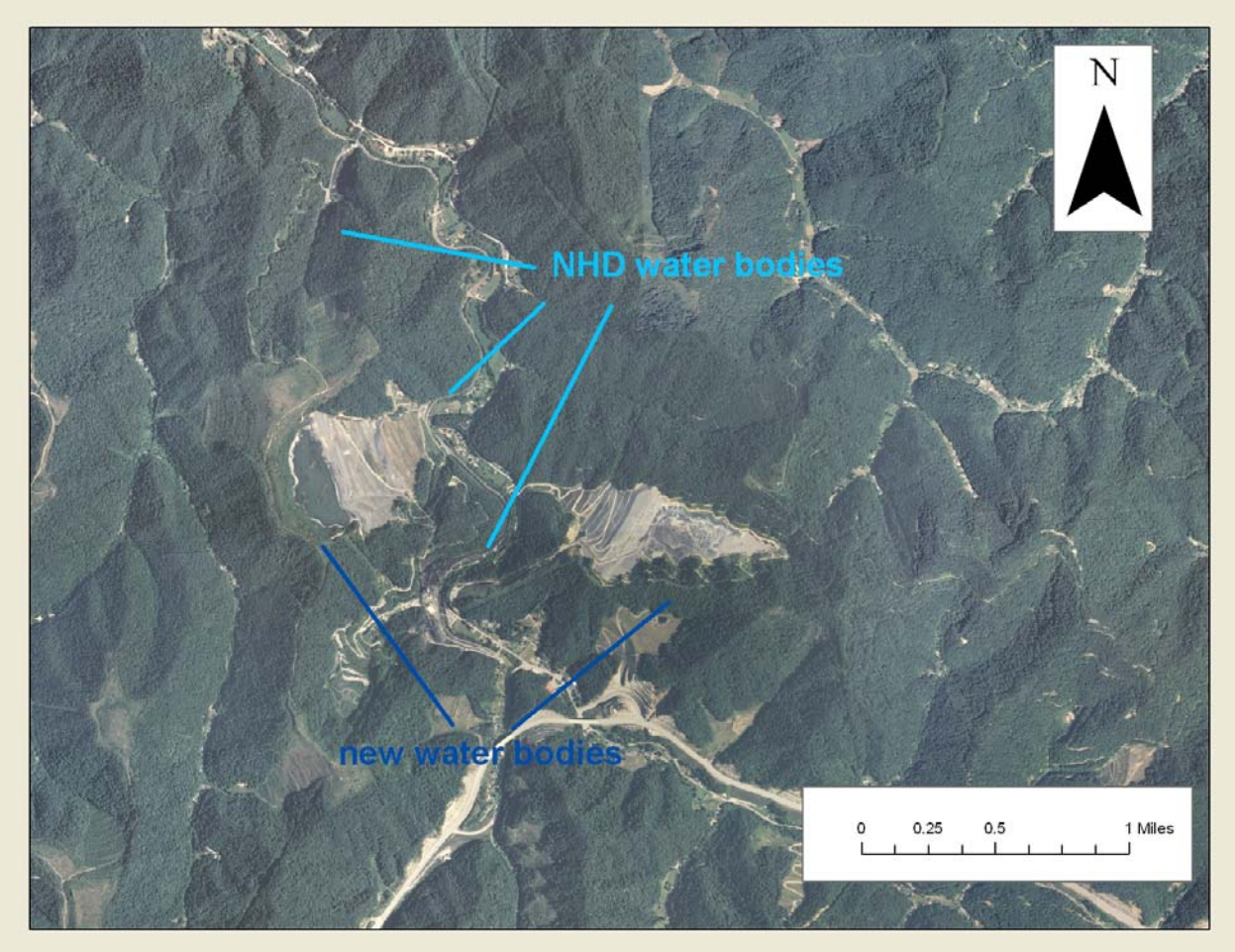

Figure 4. Water body features present and absent in NHD; aerial orthophoto (acquired summer 2008, 1 m ground resolution).

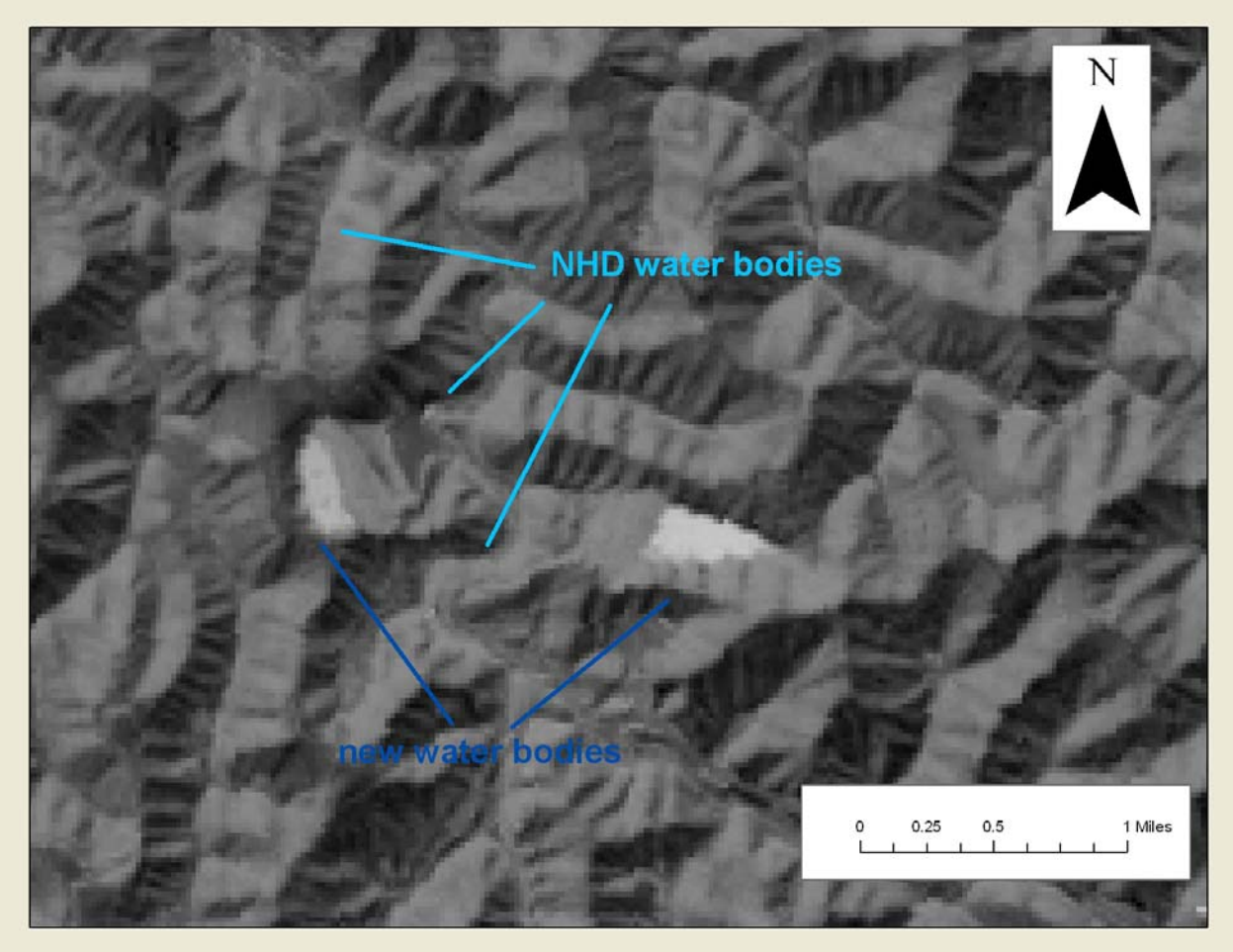

Figure 5. Wetness band of tasseled cap transform; Landsat 5 TM scene (acquired February 2009; path 19- row 34).

REFERENCES

Crist, E.P., R. Laurin, and R.C. Cicone, 1986. Vegetation and soils information contained in transformed Thematic Mapper data, In *Proceedings of IGARSS 86 Symposium*, 1465-70. Ref. ESA SP-254. Paris: European Space Agency.

Frazier, P.S., and K.J. Page, 2000. Water body detection and delineation with Landsat TM Data, *Photogrammetric Engineering and Remote Sensing*, 66(12): 1461-1467.