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Land-use/cover Factors Influencing Soil Erosion and Turbidity Issues in the Chesapeake Bay Watershed: A Multi-temporal Satellite Imagery Perspective

Abstract

The Chesapeake Bay watershed comprise of a wide-range of land-use and land-cover types within the diverse terrains of the Appalachians and Atlantic Coastal Plain. The most dominant land-use/cover classes include agricultural areas, urban and urbanizing areas, and forested areas (including riparian vegetation along the major river and stream tributaries). The ecology and water quality of the Chesapeake Bay estuary has declined over the last few decades due to increasing amounts of dissolved and suspended sediment derived from agricultural runoff and impervious surfaces in rapidly developing areas. Deriving landuse/cover components of urbanizing landscapes using multispectral and/or hyperspectral imagery is a challenging problem as illustrated by numerous studies. This is due in part to the spectral complexity of spatial- and intimate-mixtures between various vegetation and canopy types, soil and rock types, and man-made materials.

For this work, the V-I-S model of Ridd (1995) provides a useful framework for understanding landscape-scale (e.g. $\leq$ 30 meters) factors influencing runoff and erosion because it describes urbanizing landscapes as changing linear components of vegetation, impervious surfaces and soil with time. However, the large size of the Chesapeake Bay watershed (1.665×10^5 km^2) poses a "scale vs. resolution" problem in choosing the most appropriate satellite image data for temporal change analysis of V-I-S cover proportions. For example, low-resolution (250 m – 1 km per pixel) daily imagery from Terra – MODIS (and Terra – MISR) covers much of the Chesapeake Bay watershed within a single orbital swath, and provides a snapshot of turbidity levels within the bay and its largest tributaries. Unfortunately, low-resolution image sources are insufficient for accurate mapping of V-I-S cover proportions. Moderate-resolution ($\leq$ 30 m per pixel) multispectral imagery such as ASTER and Landsat, and hyperspectral imagery such as Hyperion are optimal for landscape-scale spatial- and spectral-analysis of V-I-S cover proportions. Unfortunately, these sensors are limited by temporal resolution issues such as their 16-day orbital period (4 days for ASTER if off-nadir pointing is used), limited point and tasking opportunities in the case of ASTER and Hyperion, and cloud-cover. Also, ASTER's swath size limits multi-temporal analysis V-I-S cover proportions to tributary catchment-basins at scales < 60 km wide. High resolution ($\leq$ 2 m per pixel) data sources as color-infrared ortho-imagery acquired in 2002 and LIDAR topographic data acquired in 2004 are most useful for geomorphic analysis of rill and gully features, as well as field-scale validation and ground-truth of ASTER, Landsat and Hyperion imagery.

This talk will present mapping results and temporal analysis of changing V-I-S cover in the Conestoga River watershed, which is tributary of the Susquehanna River and responsible for generating amongst the highest sediment yields for any of the tributary basins comprising the Chesapeake Bay watershed. Similar to the Chesapeake Bay watershed as a whole, the Conestoga basin contains analogous mixtures of agricultural and urban areas, and makes an adequate smaller-scale analog for understanding the relationship between changing landuse/cover factors and water-quality in the Susquehanna River and Chesapeake Bay. For example, spatial analysis of crop-cover to bare soil proportions, together with cumulative rainfall data is compared with turbidity levels in the Susquehanna River and Chesapeake Bay detected by lower resolution MODIS and MISR. LIDAR-derived slope data combined with maps of changing crop-cover and bare soil proportions will be used to show tributary basins most susceptible to rilling and gullying. ASTER data will be compared with the Landsat-derived National Land Cover Dataset for mapping impervious-dominated landuse/cover classes. I will also show ASTER-derived mineral maps showing the distribution of dispersive soils containing smectite clays which are most susceptible to impermeable sealing and enhanced runoff.

Ridd, MK (1995) Exploring a V-I-S (vegetation-impervious surface-soil) model for urban ecosystem analysis through remote sensing: comparative anatomy for cities. International Journal of Remote Sensing, vol. 16, no. 12, p. 2165-2185.

BIO:

Bernard Hubbard received his bachelors degree in geology from Cornell University in 1993, and his masters and doctoral degrees in geology from UB, in 1998 and 2001 respectively, both under the direction of his advisor Mike Sheridan. His masters thesis at UB was entitled: "Thermal Mapping of Volcanic Features Using Airborne Infrared Remote Sensors" and doctoral dissertation at UB was entitled: "Volcanic Hazards Mapping Using Aircraft, Satellite, and Digital Topographic Data: Pico de Orizaba (Citlaltepetl), Mexico".

He is currently a Research Geologist at the U. S. Geological Survey, Reston, VA, where he started his two-year post-doc in 2001 and has several articles published or in press in peer-review journals and in on-line USGS reports. His research interests include a variety of geologic applications of remote sensing and GIS such as: "landscape geomorphology and topographic modeling of volcanic flows", "impacts of landuse/landcover change on soil erosion and water quality", "use of multispectral and hyperspectral data for geologic mapping, mineral resource assessments and geologic hazard problems", "laboratory studies of clay minerals formed in different geologic environments", and most recently "soil moisture and evapo-transpiration mapping using satellite imagery". He currently spends most of his time working on revised geologic maps and new mineral resource inventories for Afghanistan, in order to aid in the economic reconstruction and development of this war-torn country.

The Geography Colloquium Series, Spring 2008
presents jointly with the Department of GEOLOGY:

Dr. Bernard Hubbard

U.S. Geological Survey

Reston, VA

"Land-use/cover Factors Influencing Soil Erosion and Turbidity Issues in the Chesapeake Bay Watershed: A Multi-temporal Satellite Imagery Perspective"

FRIDAY, MARCH 28, 2008

3:15 P.M.

FILLMORE 170

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Dr. Bernard Hubbard is a member of the U. S. Geological Survey Eastern Mineral Resources Team, which conducts unbiased research on the occurrence, quality, quantity, and availability of mineral resources in order to help the nation make informed decisions using earth-science information. Dr. Hubbard specializes in the application of remote sensing and GIS to geologic problems. Hubbard received his MS, '98, and PhD, '01, from the UB Department of Geology. During his time at UB he was recipient of a prestigious NASA Fellowship for three years followed by further research funding from NASA. He has published widely and presented at numerous professional conferences.

There will be a Reception with Pizza & Wings in the hallway outside Wilkeson 108 in the Geography Department following the presentation.

For more info on the Colloquium Series contact Chris Renschler at: rensch@buffalo.edu

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