Mapping Impervious Surfaces with High Resolution QuickBird Satellite Data

Leslie A. Morrissey (UVM), Keith Pelletier (UVM), Jennifer Callahan (VT ANR/DEC), Horace Shaw (CSB), and Tom DiPietro (CSB)

Accurate mapping of impervious surface areas is critical to stormwater management because impervious surfaces reduce infiltration of surface water into the soil, thereby increasing runoff which can carry harmful pollutants into streams and lakes. As such, the VT ANR/DEC and the City of South Burlington (CSB) sought improved and cost effective means to map impervious surfaces in their respective efforts to model TMDLs for the state's 17 impaired watersheds and develop a tax basis for the City's stormwater utility. To this end, the combination of high spatial resolution (0.6m panchromatic and 2.44m multispectral) QuickBird satellite data and advanced object oriented classification techniques yielded a mapping accuracy of 96.8% within the Potash Brook watershed. Based on the effectiveness and accuracy of these results, VT DEC and CSB adopted this approach to meet their stormwater objectives. The use of advanced object oriented classification techniques with QuickBird satellite data resulted in consistently reliable, accurate, and cost effective impervious area products.

Introduction: The recent availability of commercial high spatial resolution satellite imagery offers improved land cover characterization and data that are compatible with GIS. Although satellite data have proven too coarse to track impervious cover in the past, the City of South Burlington (CSB) and VT ANR/DEC utilized recently available high spatial resolution QuickBird satellite data (Figure 1 and Table 1) to map impervious cover.

Methods: Advanced object oriented classification was employed using both panchromatic and multispectral QuickBird satellite data, and an NDVI combined with hierarchical rules to differentiate impervious and pervious areas, and water. An accuracy assessment was conducted for Potash Brook watershed based on 300 randomly located samples that were photointerpreted from 1:1250 CIR orthophotography with field verification.

Table 1. QuickBird Satellite Data

Pixel Size (m)	0.6 pan, 2.44 MSS
Visible Bands	3 (BGR)
Near Infrared Bands	1
Scene Size (km)	16.5 x 16.5

Figure 1. Natural color, panchromatic, and CIR composite images from Digital Globe's QuickBird satellite.

Acknowledgements: Funding for this research was provided by NASA, City of South Burlington, and VT ANR/DEC. For more information contact Leslie.Morrissey@uvm.edu

Storm Water Utility

In November 1999, the EPA issued the Phase II Stormwater Rules for metropolitan areas of less than 100,000 people. To comply with these new rules, this project was developed to assist the City of South Burlington (CSB), VT in its effort to develop a stormwater utility. A critical need in any program to implement successful stormwater management policies is the ability to map impervious surfaces that are recognized to impact urban water quality. The impervious surfaces were mapped with QuickBird data acquired in 2003 (Figure 2) and updated in 2006 (Figures 3). As a result of our initial study, the satellite-derived impervious data product was adopted by CSB as the basis for its Stormwater Utility.

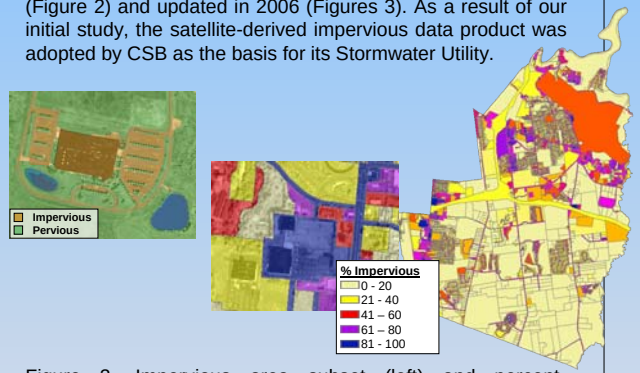

Figure 2. Impervious area subset (left) and percent impervious surface area summarized by parcel (center) and for the entire City of South Burlington, VT (right).

Figure 3. Parcels which were developed between 2003 and 2006 (indicated by increased impervious surface area) were identified (highlighted in cyan above right).

Vermont's Impaired Watersheds

VT ANR/DEC initiated a program in 2005 to model stormwater TMDLs as part of a larger effort to monitor stormwater impaired streams in Vermont. A critical input for the modeling effort was the need for accurate mapping of impervious surface areas for the state's impaired watersheds (Figure 4). Impervious surface area for the 13 impaired watersheds mapped as part of this project ranged from 5.5 – 31.3% (Figure 5). Overall mapping accuracy for Potash Brook watershed was 96.8%.

Figure 4. Impervious area summarized by subwatershed for Centennial Brook watershed.

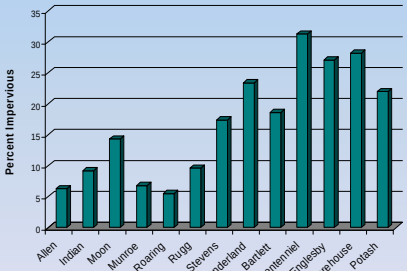

Figure 5. Percent impervious area summarized by watershed for 13 stormwater impaired watersheds in VT.

Conclusion: Advanced object oriented classification techniques based on QuickBird satellite data resulted in consistently reliable, accurate, and cost effective impervious area products. On-going efforts include the incorporation of LIDAR data to differentiate impervious cover types (e.g. buildings, parking lots, roads).