Development of an Impervious-Surface Database for the Little Blackwater River Watershed, Dorchester County, Maryland

By Lesley E. Milheim, John W. Jones, and Roger A. Barlow

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Introduction

Many agricultural and forested areas in proximity to National Wildlife Refuges (NWR) are under increasing economic pressure for commercial or residential development. The upper portion of the Little Blackwater River watershed – a 27 square mile area within largely low-lying Dorchester County, Maryland, on the eastern shore of the Chesapeake Bay – is important to the U.S. Fish and Wildlife Service (USFWS) because it flows toward the Blackwater National Wildlife Refuge (BNWR), and developmental impacts of areas upstream from the BNWR are unknown.

One of the primary concerns for the refuge is how storm-water runoff may affect living resources downstream. The Egypt Road project (fig. 1), for which approximately 600 residential units have been approved, has the potential to markedly change the land use and land cover on the west bank of the Little Blackwater River. In an effort to limit anticipated impacts, the Maryland Department of Natural Resources (Maryland DNR) recently decided to purchase some of the lands previously slated for development. Local topography, a high water table (typically 1 foot or less below the land surface), and hydric soils present a challenge for the best management of storm-water flow from developed surfaces.

A spatial data coordination group was formed by the Dorchester County Soil and Conservation District to collect data to aid decisionmakers in watershed management and on the possible impacts of development on this watershed. Determination of streamflow combined with land cover and impervious-surface baselines will allow linking of hydrologic and geologic factors that influence the land surface. This baseline information will help planners, refuge managers, and developers discuss issues and formulate best management practices to mitigate development impacts on the refuge.

In consultation with the Eastern Region Geospatial Information Office, the dataset selected to be that baseline land cover source was the June-July 2005 National Agricultural Imagery Program (NAIP) 1-meter resolution orthoimagery of Maryland. This publicly available, statewide dataset provided imagery corresponding to the closest in time to the installation of a U.S. Geological Survey (USGS) Water Resources Discipline gaging station on the Little Blackwater River. It also captures land cover status just before major residential development occurs. This document describes the process used to create a database of impervious surfaces for the Little Blackwater watershed.

Classification Scheme

The USGS and Maryland DNR discussed impervious-surface identification requirements on August 10, 2006, at the Maryland Department of Natural Resources in Annapolis. After consultation with the Dorchester County Soil and Conservation Service, the group decided to delineate roads, both residential and nonresidential rooftops, residential and nonresidential driveways, including parking areas and other impervious surfaces greater than 50 square meters such as tennis courts.

Input Data

To map land use according to the classification scheme specified, the following input data were used.

National Agricultural Imagery Program Dataset for Dorchester County, Maryland

This June-July 2005 1-meter resolution agricultural (leaf-on) imagery (NAIP_Dorchester.sid) shown in figure 2 was used to visually identify land use and land cover within the Little Blackwater River watershed (http://dnrweb.dnr.state.md.us/gis/data/data.asp).

Digital Elevation Model

An ArcGRID containing the 2-meter resolution Lidar digital elevation model (DEM) (abovebnwr) for a subset of Dorchester County, Maryland (fig. 1.) was used to identify the watershed boundary. This dataset is the mosaic of the Lidar DEM subsets available from the Maryland Department of Natural Resources. The Lidar DEM subsets used are: ab1331, ab1332, ab1333, ab1334, ab1335, ab1336, aa1331, aa1332, aa1333, aa1334,aa1335, aa1336, z1331, z1332, z1333, z1334, ab1341, ab1342, ab1343, ab1344, ab1345, ab1346, aa1341, aa1342, aa1343, aa1344, aa1345, aa1346, z1341, z1342, z1343, z1344, ab1351, ab1352, ab1353, ab1354, ab1355, ab1356, aa1351, aa1352, aa1353, aa1354, aa1355, aa1356, z1351, z1352, z1353, z1354, ab1361, ab1363, ab1365, aa1361, aa1363, aa1365, z1361, and z1363.

Study Area

These data (BufferedStudyArea.shp) identify the watershed boundary plus a 100-meter buffer (fig. 1.) for the Little Blackwater River. The file was generated from the digital elevation model above the USGS stream gage located approximately 1.5 miles downstream of the confluence of the Maple Dam Branch and the Little Blackwater River (lat. 38°30'06" N, long. 76°05'39" W) using the ArcMap 9.0 Spatial Analyst Hydrology toolkit. It resembles earlier watershed boundaries for this area except for the area east of the airport.

Roads

These data (SHA_cline_SA.shp) identify the centerlines for roads within the watershed. The original shapefile is available from the Maryland State Highway Administration website (http://www.marylandgis.net/SHAdata/list.asp) and was trimmed to the study area.

Streams

These data (SHA_streams_SA.shp) identify the streams within the watershed. The original shapefile is available from the Maryland State Highway Administration website (http://www.marylandgis.net/SHAdata/list.asp) and was trimmed to the study area.

Digital Orthophoto

These 4-meter resolution digital orthophotos (Cambr215.tif, Cambr315.tif, 1998), available from the Maryland Department of Natural Resources website (http://dnrweb.dnr.state.md.us/gis/data/data.asp), were used as ancillary data for interpretation.

Software

The following software packages were used to create the database.

- Platform: Windows XP
- Environmental Systems Research Institute (ESRI) ArcGIS Desktop 9.0 with Spatial Analyst Extension
- Habitat Digitizer Extension, Version 4 Created by Ken Buja (Ken.Buja@noaa.gov) of the National Oceanographic and Atmospheric Administration (http://ccma.nos.noaa.gov/products/biogeography/digitizer/index.html)

Processing Steps

Data Collection

ArcMap 9.0 was used to collect the study area's impervious surfaces from the agricultural imagery (NAIP_Dorchester.sid). Compilation was performed using the ArcMap editor and the Habitat Digitizer Extension. Each area was visually identified by linear patterns, texture, and color and digitized along the perceived visual boundary. Visual interpretation was performed within ArcMap at a scale of 1:1,500 and at a screen resolution of 1280 x 1024 pixels. As each area was completed, it was classified with a unique numeric identifier (UNIQUE_ID) and a description. Additional comments were entered to clarify or question the assigned classification, as needed. Boundaries were dissolved and clipped to the study area to create the final impervious-surface shapefile. The polygon areas were calculated and added to the attribute table. Polygons smaller than 50 square meters were then deleted.

Quality Assurance/Quality Control

The final impervious-surface dataset was displayed over the original imagery to visually verify that all appropriate impervious surfaces were included. The area attribute was examined to ensure that all polygons smaller than the minimum mapping unit of 50 square meters were removed.

Due to time and funding constraints, no formal statistical or sampling quality assurance/quality control measures were performed. Instead, the classified polygons were compared with the actual land use and land cover observed through an onsite visit in October 2006 to confirm the identified classes and evaluate questionable classifications. This comparison resulted in the updating of some polygon attributes to provide a greater consistency in the final set of classes. Recent development in the area precluded the confirmation of some sites interpreted as undeveloped land cover types, given the date of the source imagery.

Metadata

Metadata were generated using ArcCatalog and the Federal Geographic Data Committee (FGDC) ESRI template and are available as part of the shapefile contents.

Results

The process resulted in a shapefile (LBRW_ImpSfc.shp) containing the impervious-surface areas for the Little Blackwater River watershed as depicted in the June-July 2005 agricultural imagery. The impervious-surface polygons are shown in figure 2 over the NAIP imagery. The impervious-surface area for the 50-square-meter minimum mapping unit was compared to the total area originally gathered. The summary of this comparison is shown in table 1.

Table 1. Summary impervious surface area June-July 2005 within the Little Blackwater River watershed.

[Abbreviations: m^2, square meters; km^2, square kilometers]

Layer	Impervious-Surface Area (m^2)	Total Study Area (m^2)	Impervious Surface Area (km^2)	Total Study Area (km^2)	Percent Impervious Surface
Original digitized data	1485547	44471400	1.486	44.47	3.340
Polygons < 50 m^2 removed	1483945	44471400	1.484	44.47	3.337

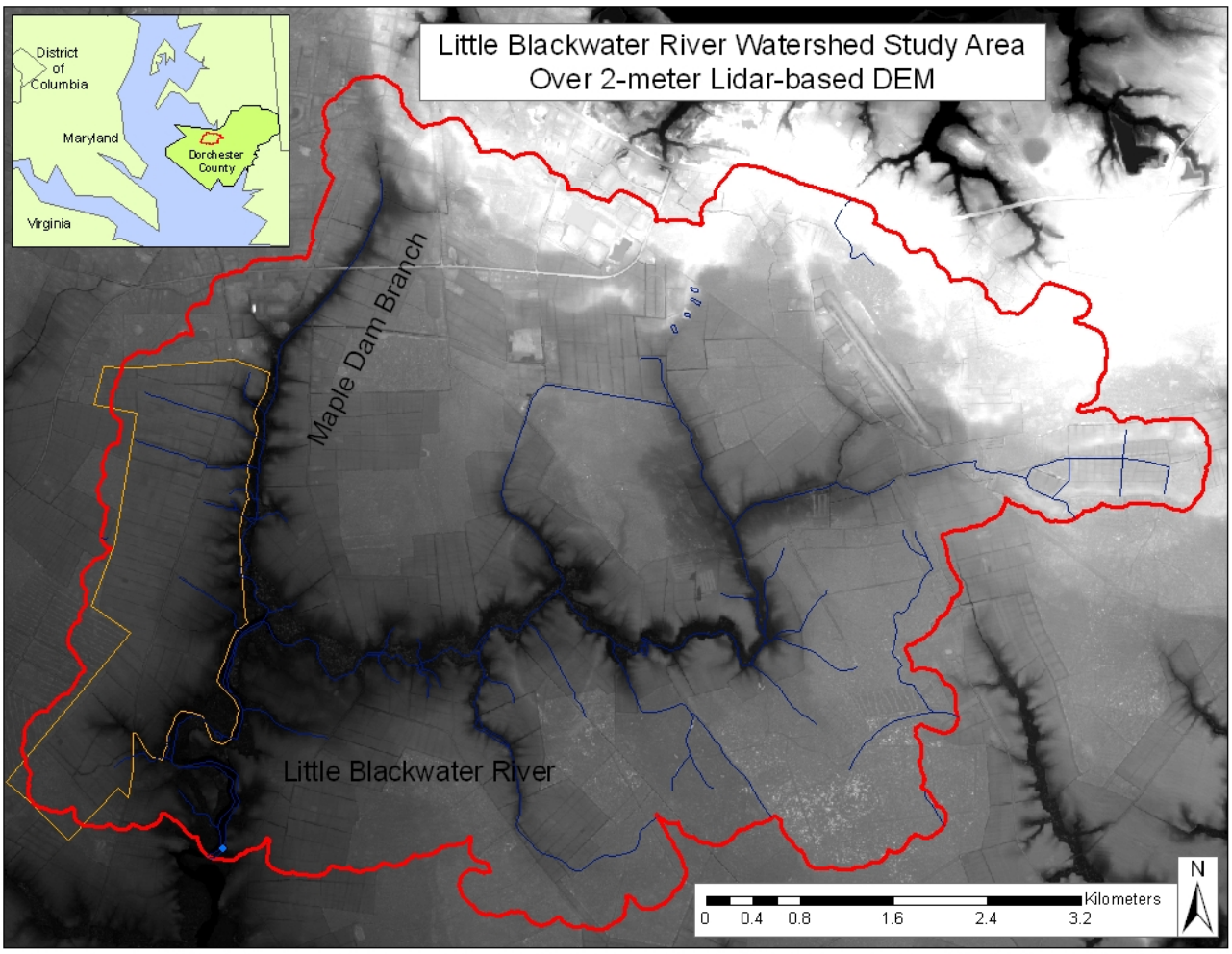

Figure 1. Lidar-based digital elevation model (DEM) of the Little Blackwater River watershed study area (44.5 square kilometers). Study area delineated by a red line (main map and index map). Watershed boundary includes a 100-meter buffer. Egypt Road project delineated by an orange line. Stream gage location identified by a blue dot.

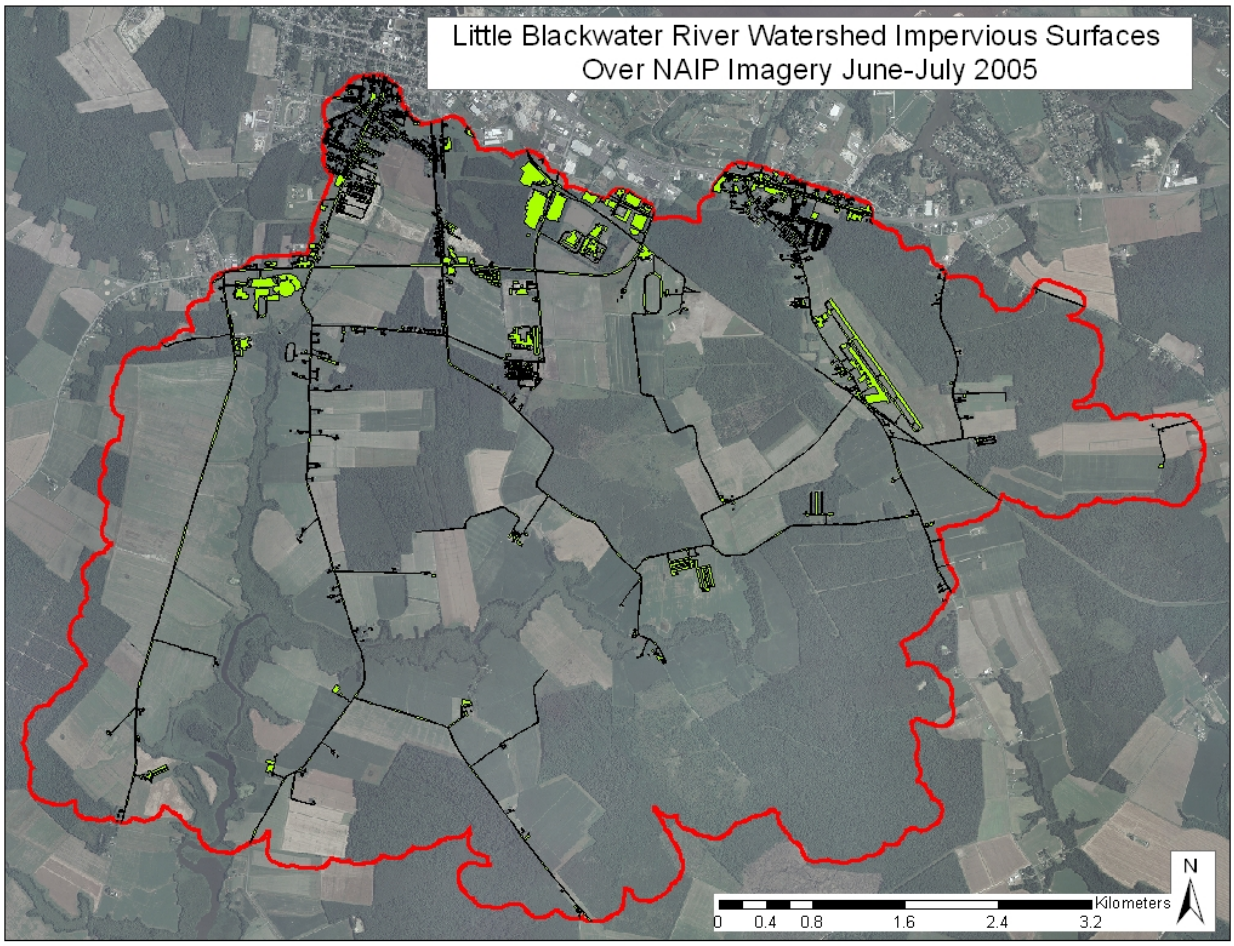

Figure 2. Impervious-surface boundaries within the Little Blackwater River watershed study area overlain on Nation Agricultural Imagery Program (NAIP) orthoimagery of June-July 2005. Study area is delineated by red line. Impervious-surface areas are depicted as green polygons and black lines.