

New Land Cover & Land Use Data for the Chesapeake Bay Watershed

Why?

The Chesapeake Bay Program (CBP) partnership is in the process of improving and refining the Phase 6 suite of models used to inform actions needed to restore the Chesapeake Bay and to meet the requirements of the Bay Total Maximum Daily Load (TMDL) pollution limits. Land cover and land use are two of the principal datasets used by the CBP modeling suite to estimate the amount of nutrients and sediments transported from the land to the Bay. In addition, localities can use such data for water resource and environmental planning, the targeting of restoration and conservation efforts, and public education and outreach.

What?

Over the past three years, the CBP partnership has collected land use (e.g., residential, commercial, agriculture), parcel, impervious surface planimetric, and other data from local governments to improve its characterization of the landscape (Figures 1-2). By combining these local land use datasets with the high-resolution land cover currently being produced, the CBP is able to create a hybrid 10-m resolution land use/land cover raster database ("Phase 6 Land Use Database") composed of 13 distinct land use/cover datasets, all of which have unique nutrient and sediment loading characteristics.

In 2015, the Chesapeake Bay Program (CBP) partnership awarded contracts for the development of new one-meter resolution land cover raster data (Figures 3 & 4) derived from aerial imagery, available LiDAR elevation data, and ancillary datasets for all 206 cities/counties whose boundaries intersect the 64,000 square-mile Bay watershed. These data will extend across the full area of each of these local governments, even those whose boundaries are partially in and partially outside the watershed. Accuracy assessments will be performed on all of these data; the target accuracies for each individual class range from 85-95%. Three different contractors are producing the high-resolution land cover data (Figure 5). The Chesapeake Conservancy (CC) is producing land cover data for the District of Columbia, Maryland, New York, and West Virginia. As a subcontractor to CC, the University of Vermont's (UVM) Spatial Analysis Laboratory is producing the land cover data for Delaware and Pennsylvania. Worldview Solutions Incorporated (WSI) is producing the land cover data for Virginia.

The one-meter resolution land cover datasets comprise 11 distinct land cover types in a single raster file. All of the land cover classes are mutually exclusive in that every cell on the map represents only one land cover type, e.g., impervious roads, impervious non-roads (Figure 6). In contrast, the Phase 6 Land Use Database consists of 13 distinct rasters that have a coarser, 10-m resolution. Each of the Phase 6 land use rasters has values representing the number of 1-m land cover cells within each 10-m cell. For example, values in the coarsened "Impervious Roads" raster represent the count of one-meter resolution impervious road cells within each 10-m x 10-m cell. Because there are 100-m² in a 10-m cell, the counts range from 0-100 and correspond directly to the percentage of the cell covered by Impervious Roads. In this way, all

of the information in the one-meter resolution land cover datasets is captured within each 10-m cell. However, because each 10-m cell represents a fraction of a particular class within it, the classes frequently overlap along the edges of buildings, roads, forest patches, and other features. For example, a 10-m cell could contain a value of 40 for impervious roads, 25 for turf grass, 15 for tree canopy over turf grass, 10 for non-road impervious, and 10 for tree canopy over impervious (Figure 7). This 10-m cell would contain forty one-meter road cells and therefore be composed of 40% roads.

The difference between categorical and fractional cell values becomes readily apparent when overlaying the Phase 6 land use raster datasets where one may see datasets at the top of an overlay obscuring the contents of datasets at the bottom of the overlay (Figures 8 and 9). The CBP selected this approach (10-m resolution cells with fractional values) to make the data more manageable by decreasing the file sizes 100-times and matching the resolution of the 10-m resolution elevation dataset (the best available for the entire watershed).

To generate the 13 land use classes from the original 11 land cover classes, some of the one-meter resolution land cover classes are combined (e.g., “tree canopy over impervious roads” combined with “tree canopy over impervious non-roads” to generate “tree canopy over impervious”) and others divided (e.g., “tree canopy” split into “forest” and “tree canopy over turf grass”; “low vegetation” split into “turf grass”, “cropland”, and “pasture”)¹ with divisions informed by spatial context and ancillary local land use and parcel data (Figure 10).

Over the past year, the Maryland Department of the Environment, Maryland Department of Planning, and the Maryland Department of Natural Resources have been working with local governments in Maryland to develop land-use estimates for use in the Phase 6 suite of models. These estimates were derived using methods specifically designed for handling the abundance of highly-detailed spatial data that is unique to Maryland. Over the next six months, Maryland agencies will work with the CBP to jointly assess which data sources and methods provide the best available characterization of land uses to inform the Phase 6 models.

Cost?

These data are freely available to local governments and other potential users. Both the one-meter resolution land cover and 10-m resolution Phase 6 Land Use Database will be available for download through the internet. In addition, tabular data will be provided that indicates the acreage of each land use informing the CBP partnership’s Phase 6 suite of models by modeling segment (i.e., small watersheds within each county).

¹ Note that the Phase 6 Land Use Database will be used to determine the total amount of agricultural land (cropland + pasture) within each county. The cropland and pasture classifications will only be used to proportionally allocate detailed data on crop type and pasture reported in the Census of Agriculture to Phase 6 model segments within each county.

Data Type and Format?

All aerial and satellite imagery as well as elevation data are produced as rasters. Rasters are simply grids of equal-area sized cells (aka “pixels”). All of the land cover and land use data produced for the Bay watershed will be stored and distributed as 1-m resolution or 10-m resolution rasters in TIFF format (*.tif) and projected in Albers Equal Area USGS version, NAD 1983, meters. Due to the granularity of the land cover data (1-m x 1-m cells), rasters provide the most efficient data type for storage and analysis. Converting these data directly to vector format would generate very large files with millions of vertices and polygons. While the data could be smoothed or otherwise generalized prior to conversion, doing so would result in the loss of information.

When?

The high-resolution land cover data are currently under development and will be completed incrementally following a rolling production schedule from January through July 2016. The Phase 6 Land Use Database will be produced concurrently following quality assurance, local review, and an accuracy assessment of the high-resolution data. The Phase 6 Land Use Database will be finalized in September 2016 and all of its data will be accessible and available to the public in November 2016.

Local Review?

Local jurisdictions outside of Virginia will be asked to review the high-resolution land cover data to help identify systematic errors in the mapping of land cover classes, e.g., impervious surfaces, trees, low vegetation, etc. Following production of the Phase 6 Land Use Database, all local jurisdictions including those in Virginia will be asked to review the Phase 6 Land Uses and overlay data to help identify errors in the mapping of turf grass, agriculture, open space, water, wetlands, roads, sewer service areas, MS4 (Municipal Separate Storm Sewer System), and CSO (Combined Sewer Overflow) boundaries.

During the rolling production schedule, CC and UVM will provide state and county planning officials with access to draft land cover datasets for a three-week review. In Virginia, an independent contractor (Sanborn) will assess the quality and accuracy of the WSI land cover products. Once these activities are complete for a set of counties, the CBP will produce the draft Phase 6 Land Use Database for those jurisdictions and post the data on a website for a four-week jurisdictional review. The CBP partnership has developed lists of local government contacts who will be notified when the draft land use data are ready for review.

Jurisdictional reviews of the high-resolution land cover data (in all states except Virginia) and Phase 6 Land Use Database (everywhere in the watershed) should focus on the identification of systematic errors, i.e., errors that are pervasive and consistent throughout the datasets, and large-area errors (e.g., isolated misclassification of large features such as business parks, ponds, etc.). Systematic errors can be addressed through changes to decision rules or the inclusion/reinterpretation of ancillary data on roads, impervious surfaces, or land use. Large-area errors can be addressed through manual editing of the high-resolution data. The

contractors have limited resources, so they will be unable to address small-area isolated errors such as the misclassification of a few buildings or patches of trees.

Once the high-resolution land cover data are finalized, the CBP Office will not make any edits or changes to them. Changes to the Phase 6 Land Use Database -- all 13 raster datasets -- will require the provision or reinterpretation of ancillary data (e.g., parcels, planimetric impervious surfaces, or land use data).

CC and UVM will launch separate websites for each batch of high-resolution land cover data that they produce. CC will coordinate with the District of Columbia, Maryland, New York, and West Virginia; UVM will reach out to Delaware and Pennsylvania stakeholders. Both will contact local jurisdictions and provide links to these websites following the production of each batch of data.

Virginia's high-resolution land cover data developed by WSI will be available to localities following completion of Sanborn's quality assurance/quality control process and any necessary corrections by WSI. The data will be available on the VGIN GIS Server at:

<http://gismaps.vita.virginia.gov/arcgis/rest/services>

The U.S. Geological Survey has developed a website to facilitate review and dissemination of the Phase 6 Land Use Database; the website works best using Google Chrome and can be accessed at: <http://chesapeake.usgs.gov/phase6/>

More Information?

For more information, you can download a recording of a January 29th Bay Program webinar that provides an overview of the local land cover/use data. In addition, a Frequently Asked Questions document (produced following the webinar), and the data production/review schedule will be available at the following website:

<http://www.chesapeakebay.net/calendar/event/23454/>

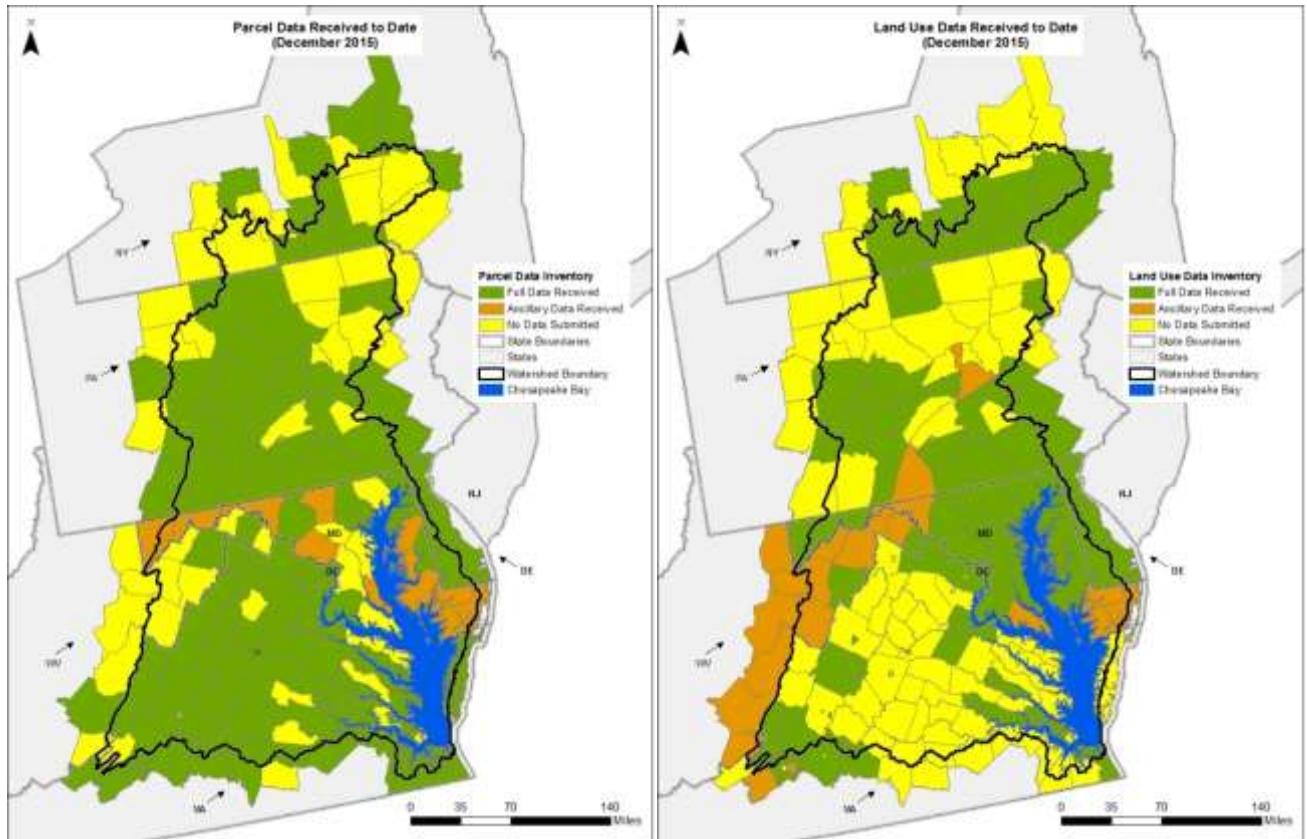
Points of Contact

Phase 6 Land Use Database:

- U.S. Geological Survey: Fred Irani, firani@usgs.gov

High-resolution Land Cover Datasets:

- Chesapeake Conservancy: Cassandra Pallai, cpallai@chesapeakeconservancy.org
- University of Vermont: Jarlath O'Neil-Dunne, Jarlath.ONeil-Dunne@uvm.edu
- Virginia Department of Environmental Quality: James Davis-Martin, James.Davis-Martin@deq.virginia.gov



Figures 1 & 2. Local parcel and land use data collected by the CBP Partners.



Figures 3 & 4. Example of a recent high-resolution aerial image (left) and 2013 classified land cover dataset (right) for an area in Prince George's County, Maryland.

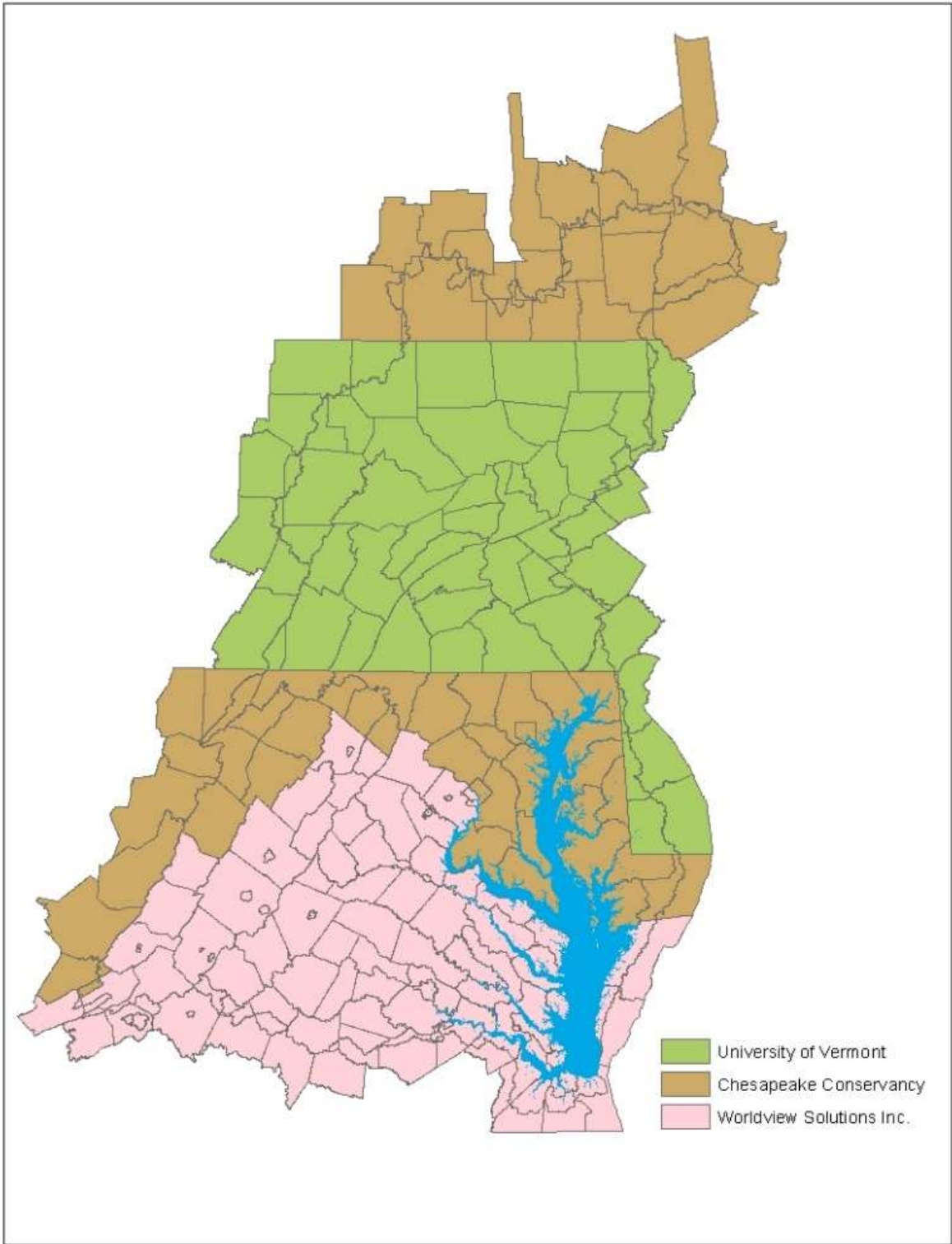


Figure 5. Regions covered by each of the three contractors producing the 2013/14 high-resolution land cover datasets.



Figures 6. High-resolution (1-m) representation of roads (black), other impervious surfaces (red), and low vegetation (green).

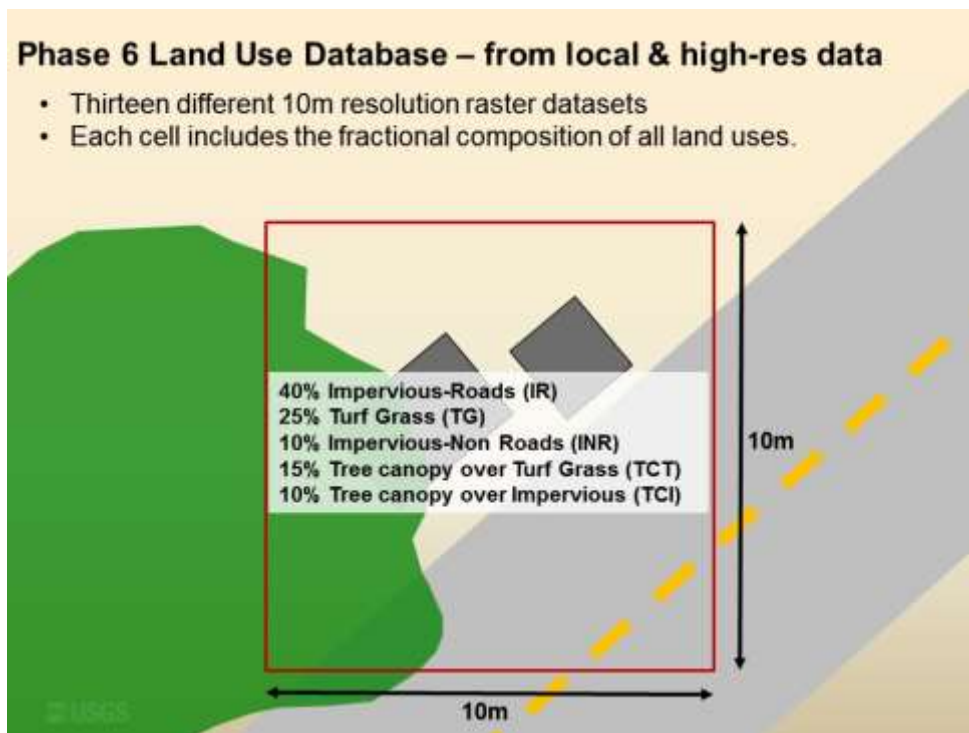


Figure 7. Example of fractional land use composition within one 10-m resolution cell.



Figures 8 & 9. Ten-meter resolution land cover data using the same extent as shown in Figure 7. In the left image, the order of the overlay from top to bottom is: roads (black), other impervious (red), and low vegetation (green). In the right image, the data were re-ordered with low vegetation moved on top of roads and other impervious surfaces.

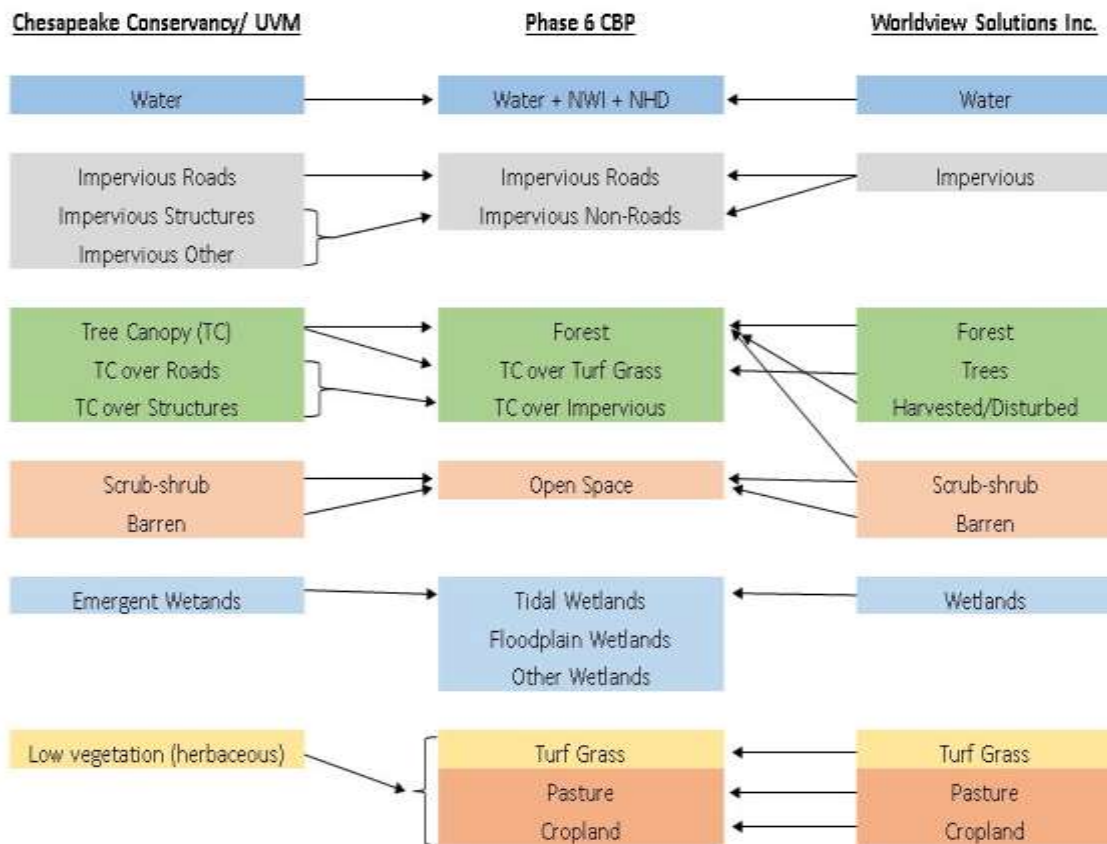


Figure 10. Crosswalk of high-resolution land cover types to Phase 6 land uses.