High-Resolution Land Cover Dataset 101

Background

Accurate land cover information is one of the most important spatial datasets needed for environmental management--used for everything from regional habitat modeling to quantifying impervious surface extent for planning purposes. The Chesapeake Bay Program (CBP), a regional partnership that helps lead, direct, and manage restoration efforts in the Bay watershed, uses land cover data to model, track, and manage watershed-wide progress toward reaching the 2025 water quality goals established through the United States Environmental Protection Agency's (EPA) Chesapeake Bay Total Maximum Daily Load (TMDL).

The TMDL is a "pollution diet" created by the EPA in 2010 with the intent to restore water quality in the Chesapeake Bay. The Chesapeake Bay Watershed drains 64,000 square miles across six states and the District of Columbia. The new TMDL has directly affected both state- and county-wide policy and regulation and has stimulated a number of new pollution reduction initiatives at all levels of government.

Existing datasets, such as the National Land Cover Dataset (NLCD), have proven extremely useful in identifying priority landscapes throughout the Chesapeake Bay watershed in need of conservation and restoration. However, these data often lack the resolution needed to identify, examine, and track fine-scale trends in land cover change or to make parcel-scale decisions about how and where to focus restoration efforts.

To help bridge the gap, the Chesapeake Conservancy (CC), a nonprofit organization based in Annapolis, MD, proposed a project to produce consistent high-resolution land cover for the extent of all of the counties that comprise the Chesapeake Bay watershed (~100,000 square miles of land). In 2015, CBP commissioned the upgrade to their watershed landscape data from the Chesapeake Conservancy, which worked with the University of Vermont Spatial Analysis Lab and WorldView Solutions Inc. to create the one-meter resolution dataset that covers all counties intersecting the Chesapeake Bay watershed boundary.

Frequently Asked Questions

Where can I find the data?

The complete dataset can be found on the Chesapeake Conservancy's website, under the Conservation Innovation Center tab, "Land Cover Data Project."
https://chesapeakeconservancy.org/conservation-innovation-center/land-cover-data-project/

Will it be downloadable?

Yes, the data for NY, PA, MD, DE, DC, and WV is available for free direct download on our webpage[1] and VA data is accessible via the website linked under the Virginia tab. Virginia data also is available for viewing and direct download here[2].

1. https://chesapeakeconservancy.org/conservation-innovation-center/land-cover-data-project/
2. http://vgin.maps.arcgis.com/home/item.html?id=6ae731623ff847df91df767877db0eae

What is available?

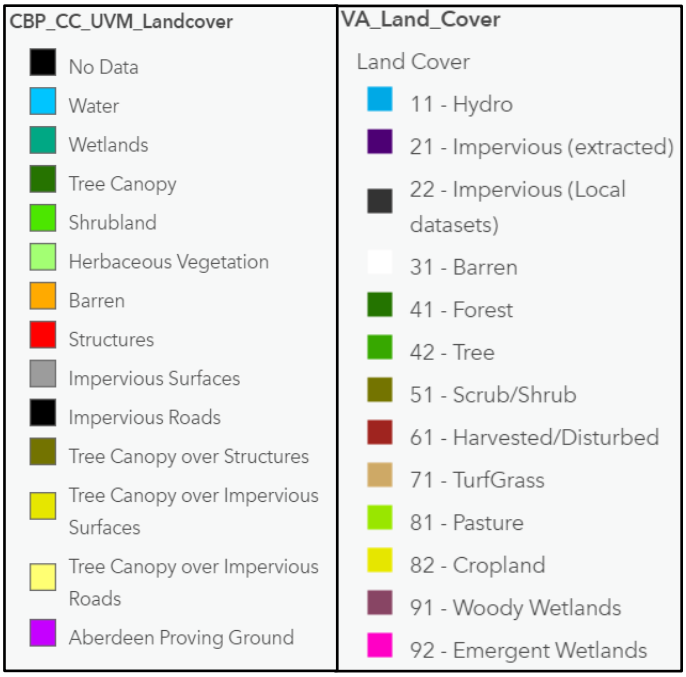


Figure 1: Land Cover Classes for NY, PA, DE, MD, WV, and Washington D.C.

Figure 2: Land Cover Classes for VA

Datasets for all the states comprising the watershed are currently available at the statewide and county level. The land cover data for MD, NY, PA, DE, WV, and Washington D.C. has 12 classes not including the No Data and Aberdeen Proving Ground classes. VA land cover data is broken into 13 classes. A uniform 7-class bay-wide dataset will be available in the new year, with the classes outlined in Figure 3.

Figure 1 has the classes listed for the states done by Chesapeake Conservancy (CC) and University of Vermont Spatial Analysis Lab (UVM SAL), and Figure 2 has the class numbers and land cover type as assigned for VA, as completed by WorldView Solutions Inc.

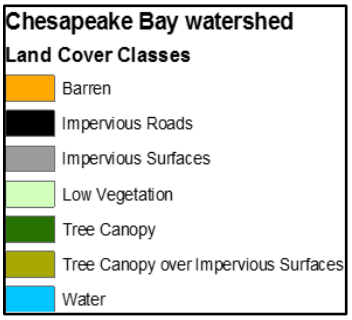


Figure 3: Land Cover Classes for Uniform Bay-Wide Dataset

When you open the datasets completed by CC and UVM SAL in ArcDesktop it will be symbolized by the numerical value rather than the name, where: 0=No Data, 1=Water, 2=Wetlands, 3=Tree Canopy, 4=Shrubland, 5=Herbaceous Vegetation (Low vegetation), 6=Barren, 7=Structures, 8=Impervious Surfaces, 9=Impervious Roads, 10=Tree Canopy over Structures, 11=Tree Canopy over Impervious Surfaces, 12=Tree Canopy over Impervious Roads, 13=Aberdeen Proving Ground, 14=No Data, 15=No Data.

You can change this by right clicking the layer in ArcDesktop, selecting properties, and the Symbology tab. Then select "unique values", and manually select the colors you would like for each land cover class. You can then click the folder in the top right corner of the screen to save and import into other maps later.

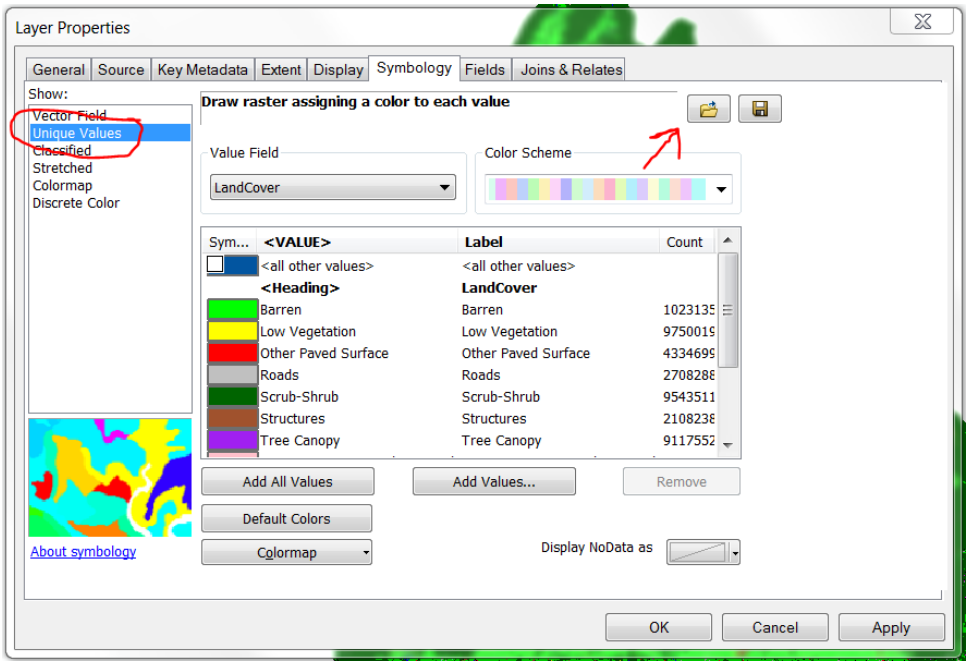


Figure 4: Example of Symbology Tab to Change Land Cover Class Colors

What other resources will be available?
Metadata, with more information about the classification and component datasets, is attached to the downloadable land cover as an XML file.

Tables with source dates and years is also available at the end of this document for the District of Columbia, Maryland, New York, and West Virginia (Table 1) and for Pennsylvania and Delaware (Table 2).

Links to relevant webinars and websites are listed below, and a recording of the webinar presented on 12/8, 12/12, and 12/14 about the context behind the Chesapeake Bay Watershed High Resolution Land Cover Project, methodology, and user cases will be available on our website (www.chesapeakeconservancy.org) in the new year. Additionally, the land cover data accuracy assessment methodology, as well as results by state, will be posted to the same location in early 2017.

- Land Cover Project Download Site:
    - https://chesapeakeconservancy.org/conservation-innovation-center/land-cover-data-project/
- Chesapeake Bay Land Cover Project Webinar by Margaret Markham and Jarlath O'Neil-Dunne from 12/8, 12/12, and 12/14:
    - http://epawebconferencing.acms.com/p20o4o3dv7x/
- Chesapeake Bay Program Land Use Workgroup:
    - http://www.chesapeakebay.net/groups/group/land_use_workgroup
- Chesapeake Conservancy Phase 6 Land Cover Production Webinar by Cassandra Pallai:
    - https://epawebconferencing.acms.com/p1fr82q9b69/?proto=true
- Chesapeake Bay Program and Chesapeake Conservancy Press Release about the Land Cover Project:
    - https://chesapeakeconservancy.org/2016/12/06/chesapeake-bay-restoration-benefit-groundbreaking-technology-advancement/

How do I open the metadata? Which xml file should I open?

The metadata is included in the folder that downloads from the Chesapeake Conservancy website. Once you download and save the folder on your computer, there will be two different files that are in XML format but with different extensions, as demonstrated in the image to the right, Figure 5. Using Franklin County, PA as an example the two files will read as “FranklinCounty.tif” and “FranklinCounty.tif.aux”, the metadata is attached in the file that ends as “.tif” **not** “.tif.aux”.

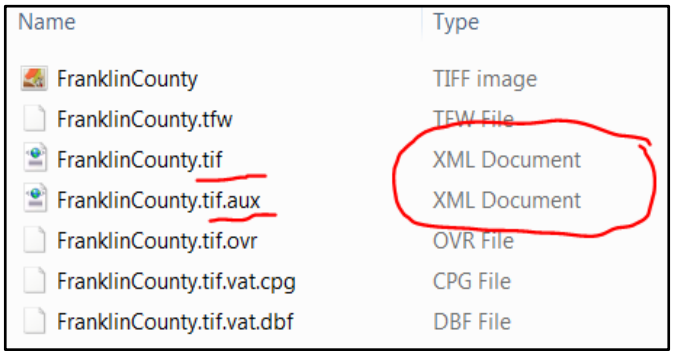


Figure 5: Files as Shown in Folder Once Downloaded

When you double click this file, it will open in your default browser (probably Internet Explorer), shown in Figure 6.

Figure 6: Metadata in Browser Window

For a cleaner look, you can also view the metadata through ArcCatalog by selecting the .tif file in your folder and “description” in the third tab to the right, as Figure 7 demonstrates.

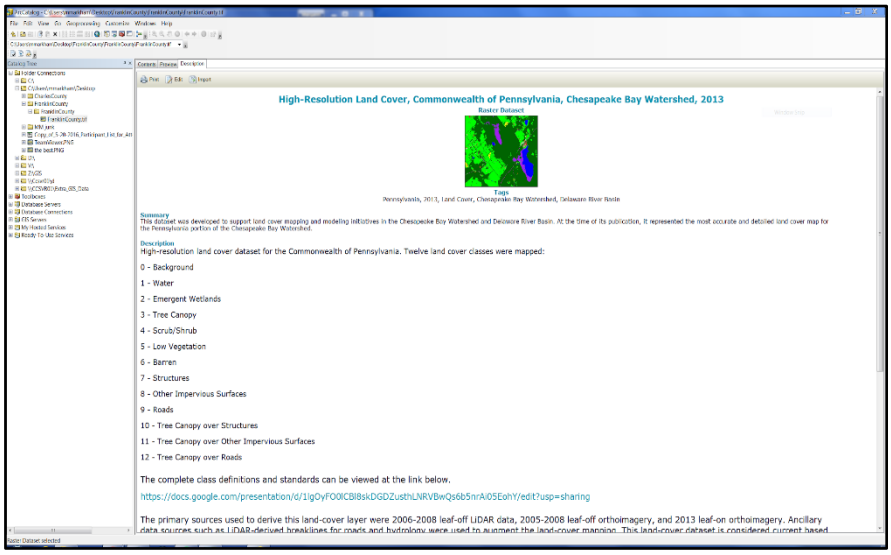


Figure 7: Metadata Shown in ArcCatalog

From there, select “Customize” at the top of your screen, and “ArcCatalog Options” at the bottom of the drop down menu. A window, as shown in Figure 8, will open up. Select the “Metadata” tab, and where a drop down choice reads, “Item Description” change it to, “FGDC CSDGM Metadata”. By doing this, you can view the FGDC compliant metadata. After changing this setting, more information will be available in the body and by scrolling to the end of your window and clicking “FGDC Metadata (read only)”.

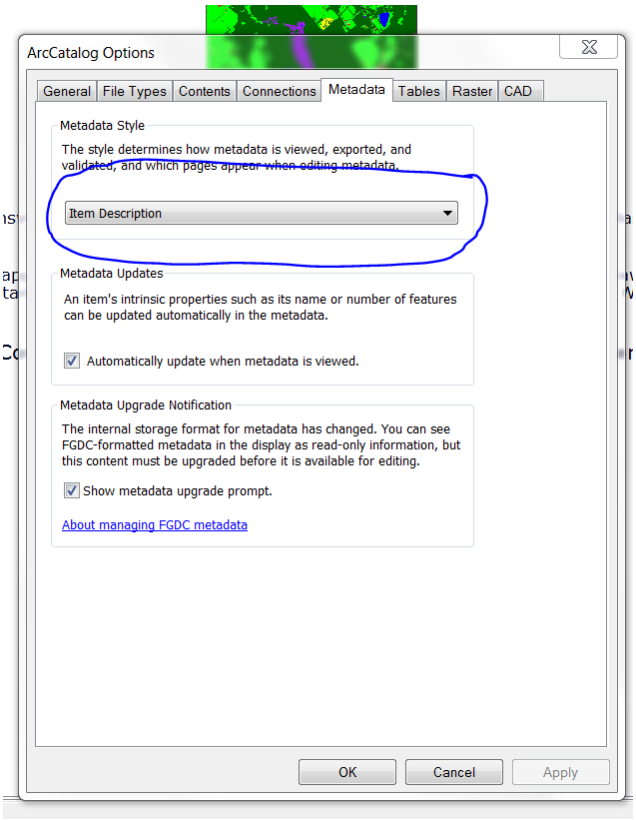


Figure 8: Menu to change metadata settings

What are future uses and plans? Will historical data be available?
Chesapeake Bay Program is working on backcasting and forecasting land development, right now there is no historical data like this and this is the only uniform dataset that exists. There are hopes (plans, intentions, etc.) to try and update this, or a similar dataset, approximately every two to five years.

Why is our data in raster format?
The data was created and processed based off aerial imagery, which is a raster format. Typically, vector data is generated entirely through manual classification and editing, which would not have been possible due to scale of this project.

Which organization has developed the data for my state/county?
WorldView Solutions, working with Virginia Department of Environmental Quality, was responsible for the state of Virginia[1]. University of Vermont Spatial Analysis Laboratory was responsible for the data in Pennsylvania and Delaware[2]. Chesapeake Conservancy was responsible for the data in Maryland, Washington D.C., West Virginia, and New York[3].

1. http://vgin.maps.arcgis.com/home/item.html?id=6ae731623ff847df91df767877db0eae
2. https://www.uvm.edu/rsenr/sal/
3. http://chesapeakeconservancy.org/conservation-innovation-center/land-cover-data-project/

What kind of attributes are contained in the 1-meter land cover data?
In the attribute table of the downloaded land cover data, pixel counts (i.e. the number in field "Count") will be listed for each class in square meter units. To convert from square meters to acres, multiply the pixel count field by the number 0.000247105. Other supplemental information is available in the metadata attached to the land cover, and in resources such as this.

ANNE_24003_USGS.tif

OID	Value	Count	LandCover
0	1	458865082	Water
1	2	3847838	Wetlands
2	3	632321813	Tree Canopy
3	4	6899821	Shrubland
4	5	261317117	Low Vegetation
5	6	2214995	Barren
6	7	35999557	Structures
7	8	60030376	Impervious Surfaces
8	9	37670167	Impervious Roads
9	10	8021266	Tree Canopy over Structures
10	11	19980874	Tree Canopy over Impervious Surfaces
11	12	10654923	Tree Canopy over Impervious Roads

Figure 9: Count Field as Shown in Attribute Table

Are headwater streams mapped?
Not reliably in the land cover data; tree canopy and shadows in the imagery eclipse smaller-order stream reaches, which prevents classification.

There will be an enhanced stream layer that incorporates land cover data for the Susquehanna River Watershed that will be available for download in the new year.

How frequently will these land cover data be developed and made available?
This remains to be determined. The estimated refresh rate will be between two to five years.

Will LiDAR dates and land use dates be used to estimate a baseline date for conditions, from which loading and reduction rate calculations will be made for TMDL tracking?
For developing the land cover information in the Phase 6 watershed model, the Chesapeake Bay Program Partnership is in the process of coming to consensus on whether to continue using 2010 as the baseline year, or to transition to 2013 as an updated baseline built on the high-resolution land use data. More information about this decision-making can be found through the Chesapeake Bay Program Water Quality Goal Implementation Team[1].

1. http://www.chesapeakebay.net/groups/group/Water_Quality_Goal_Implementation_Team

What data sources were used to create my dataset?
The short answer is that LiDAR, NAIP imagery, and orthoimagery when available were used, as well as county planimetrics, statewide and federal road datasets, and National Wetlands Inventory[1] polygons. For a more complete source guide for Washington D.C., MD, NY, and WV please see Table 1, and for PA and DE see Table 2.

For UVM source data, please see the metadata being hosted on PASDA[2].

For LiDAR used by the Chesapeake Conservancy to extract tree canopy in Virginia please see the Virginia LiDAR website[3].

1. https://www.fws.gov/wetlands/
2. http://www.pasda.psu.edu/uci/FullMetadataDisplay.aspx?file=landcover_2013_pennsylvania_chb_drb.xml
3. http://virginialidar.com/index-3.html#.WFl9F1MrKyo

Is there a LiDAR coverage map for the Chesapeake Bay watershed?
LiDAR coverage for the country is viewable here: https://coast.noaa.gov/dataviewer/#/lidar/search/. Note that NOAA intermittently works on updating this layer. LiDAR data usages for the land cover project can be seen in Tables 1 and 2.

Common Operations

The following are all ESRI ArcGIS Desktop operations, some require a Spatial Analyst license. The operations below were common tools our own analysts used to tackle obstacles and solve problems they encountered throughout our land classification process. These operations also represent a compilation of frequently asked questions from outside parties concerning manipulating such a large dataset, and one that is in raster form.

1. Field Calculator

Problem? I want to calculate class area (raster)/pixel count to area.

Solution: Field calculator is a tool available in the attribute table of a layer. By right-clicking the name of a field in the attribute table, a drop down list will appear with several options, the Field Calculator window opens as seen in Figure 10.

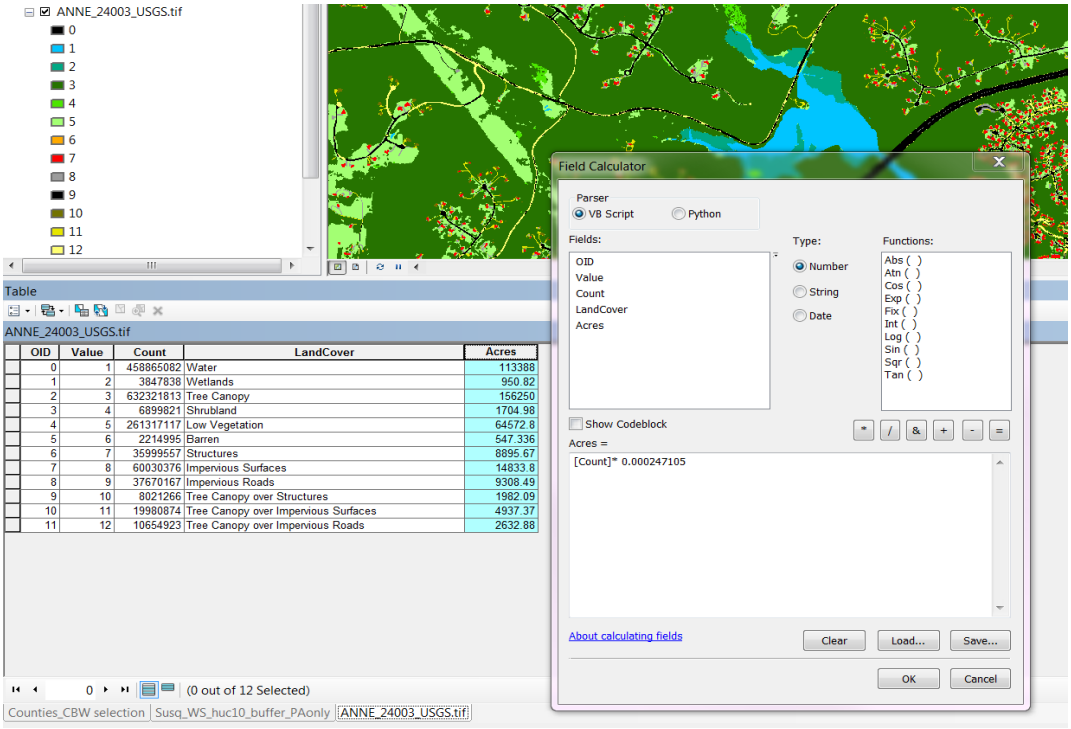


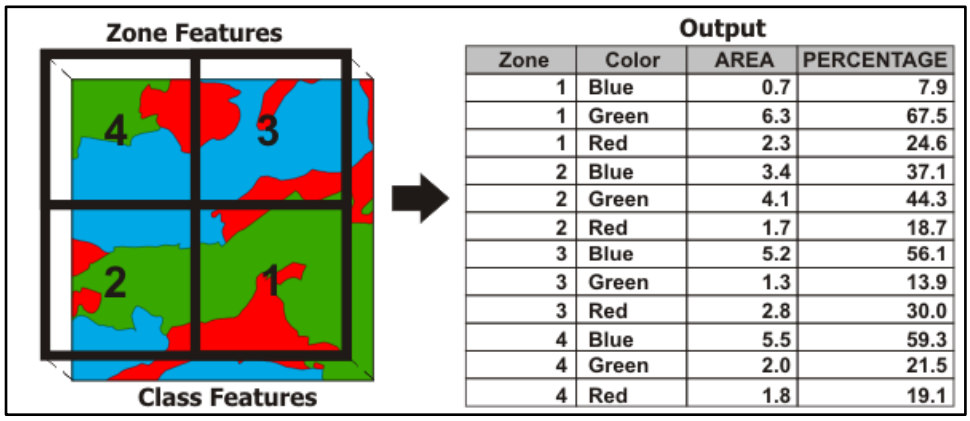
Figure 10: Field Calculator Window as Seen in ArcDesktop

Field calculator allows you to select a field and edit values within that field directly or you can use this tool to perform a calculation within the field, such as converting units. You can use this tool on one selected value, or for multiple values through a batch process. Examples of functions you can use this tool for are calculating area and length, conversions, or you can assign a different value to manually reclassify a field. The example above is showing how to convert the count column in the table to the left from square meters into acres, a more common unit of measurement often times. To do this, "add field" was selected from the drop down menu in the top left corner and labeled as "Acres". Then, after right-clicking the new column the field calculator window, as seen to the right in Figure 10, was opened. By double clicking the field desired, "Count", we were then able to multiply the values by the appropriate conversion number, effectively filling out the new value for our Acres field.

2. Tabulate Area

Problem? You want to know the area of land cover within a parcel.

Solution: Tabulate area is a part of the Zonal tools and available with a Spatial Analyst license. Zonal tools allow the user to perform analysis by computing equations on each cell that belongs to an input. Zonal tools are used to quantify a targeted characteristic, or property of a specified area of land. Tabulate area is an example of this, and can be used to calculate the area of a class, like low vegetation, within a zone, such as a parcel from a county parcel dataset. Zones can be one single area, or a number of disconnected areas, but all shared and defined by the same value. Figure 11 is an example from ESRI[2], and helps illustrate this--the "color" field in this example is a "land cover class" within in a zone, where its area is calculated and extracted per zone, which are numbered 1-4 (think about parcel data). The output is a table that can be joined (see 12) to a polygon for further analysis.



Zone	Color	AREA	PERCENTAGE
1	Blue	0.7	7.9
1	Green	6.3	67.5
1	Red	2.3	24.6
2	Blue	3.4	37.1
2	Green	4.1	44.3
2	Red	1.7	18.7
3	Blue	5.2	56.1
3	Green	1.3	13.9
3	Red	2.8	30.0
4	Blue	5.5	59.3
4	Green	2.0	21.5
4	Red	1.8	19.1

Figure 11: ESRI Image Example of Tabulate Area Tool

3. Calculate Geometry within Attribute Table

Problem? I want to select out features based on area of a feature but it's not included in the attribute table.

Solution: The calculate geometry tool, similar to the field calculator tool, allows the user to calculate the area, length, or perimeter of features. If you're interested in the area of a feature, a quick and easy way to calculate this is by adding a new field in the attribute table of the layer you're working with and right-clicking it. A drop down list will appear, select "calculate geometry" where you can then select which operation you wish to be completed and in what kind of unit.

4. Reclassify

Problem? You want to change the values of classifications to match a different number schema.

Solution: Reclassify refers to the ability to change the values in a raster to reflect chosen values. In order to use the reclassify tool you need a Spatial Analyst license and valid statistics. You can calculate statistics if they do not exist with the "Calculate Statistics" tool in the Data Management Tools toolbox.

5. Raster to Polygon

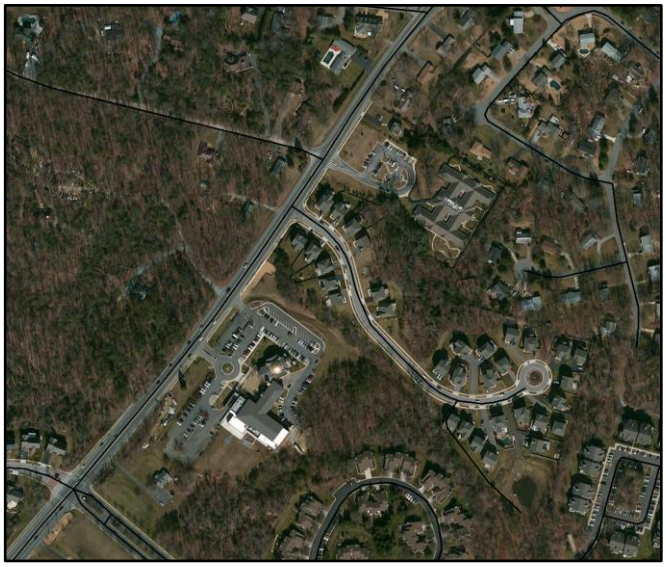
Problem? You want to perform an operation on a dataset that can only be done using polygon features, such as editing verticies of a parking lot that was slightly off in the land cover.

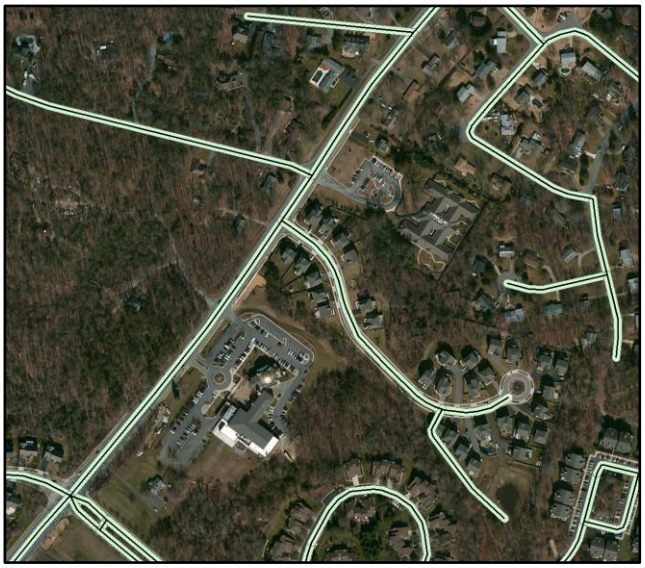
Solution: The Raster to Polygon tool is used to convert a raster dataset into polygon features. By being able to convert back and forth you are able to make use of a much broader range of tools within ArcMap, which allows for more creativity and flexibility when using different data and solving certain GIS problems.

6. Buffer

Problem? You have centerline road data, but would like to estimate actual road coverage.

Solution: A Buffer creates polygons around specific features that reach a specific distance away from said feature. The Buffer tool is a part of the Analysis toolbox, which can often be used for solving spatial and statistical problems. This feature then can be dissolved to create one dataset. Figures 12 and 13 show a road centerline layer that has been buffered out, shown by the mint green color, to mimic the real width of roads on the ground.





Figures 12 & 13: A Road Before and After Being Buffered Out

7. Project

Problem? You've pulled in layers with two different projections.

Solution: The Project tool is only used when there is already a coordinate system applied to the data. If the data's projection is undefined, you will use the Define Projection tool. Both tools can be found in the Data Management toolbox, under Projects and Transformations. To find how each layer has been assigned, right click the layer and select "Properties," then in the dialog box that opens select "Source" to find which coordinate system the layer is projected in.

8. Image Analysis

Problem? You're interested in visualizing a mosaicked land cover dataset comprised of data from several counties. However, you don't want to invest the processing time.

Solution: The Image Analysis window can be opened in ArcMap and docked or pinned to the window similarly to results, search, or toolboxes. Users can find this option by right clicking "Windows" at the top of their screen, located in between "Customize" and "Help", and selecting "Image Analysis" at the bottom of the drop-down menu. This window includes features that help the user analyze and manipulate image and raster data by providing options for how to display the data, various processes, and including tools for measurement. Making this tool particularly convenient because it lists out all the raster data layers together under a layer tab, and allows processing on the fly using a temporary layer, rather than making the user create an often timely more permanent layer. The layer created can then be exported as a new raster dataset or saved as a layer file if the user decides that is the final format they want.

9. Virtual Clipping.

Problem? Following the problem outlined in #8 above, you're interested in clipping a virtual mosaic to your analysis extent of a watershed that crosses state and/or county boundaries.

Solution: The Clip tool works on vector data only, not raster. If you need to convert your data to use this tool see the above mentioned suggestion of using a Raster to Polygon tool. The Clip tool can be found in the Analysis toolbox and allows you to cut out a specific area of lines, points, and polygons by acting as a cookie cutter and extracting only the area of interest but retaining the attributes of the features you want.

10. Mosaic to New Raster

Problem? You're working with a number of different datasets and it would be easier if you could save just one that you could open later, or in multiple maps.

Solution: The Mosaic to New Raster tool is available in the Data Management toolbox, and allows analysts to merge multiple raster datasets into one new raster dataset. In order for this tool to work, however, you must make sure all the inputs are in raster format with the same number of bands and bit depth, which can be checked by opening the layer properties window of the rasters you would like to merge together.

11. Batch

Problem? I have to perform the same function over and over again.

Solution: The ability to Batch process something is key to efficiency, especially when working with large datasets that can take a long time to complete an operation. In order to eliminate repetition, which also helps cut down on human error, you can choose "batch" for any geoprocessing tool in ArcGIS desktop. Right click the tool and select "Batch"; this will open up a new dialog box with a row for each step.

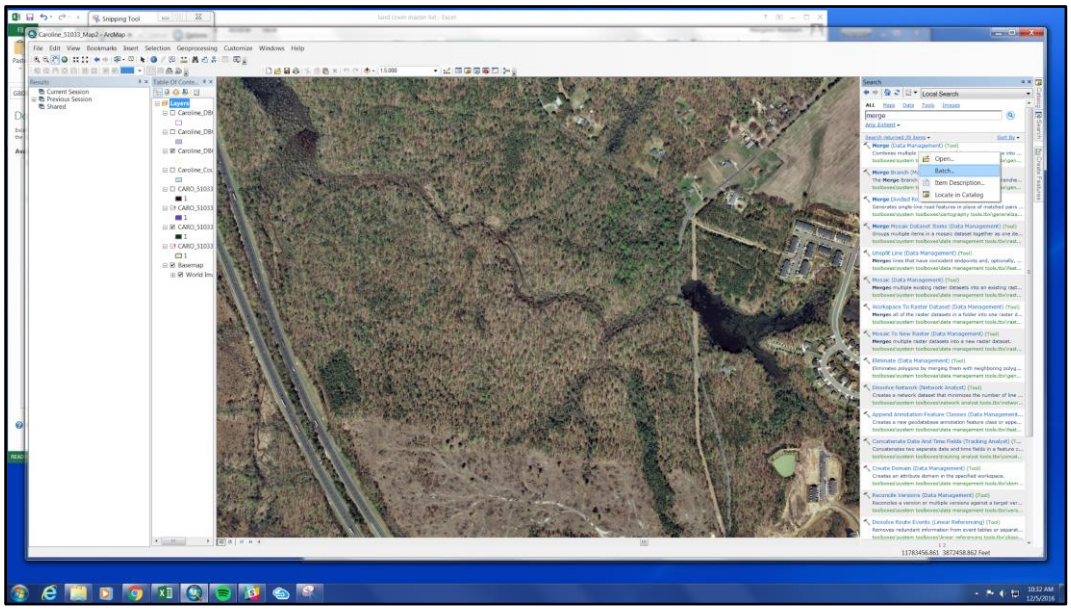


Figure 14: Example of Batch Option

12. Join Table

Problem? You used the Tabulate Area tool (See number 2) that created a table, and you want to combine it with a layer.

Solution: Often times a Join is used to append a column, or fields, of one table to an attribute table of another table through a field that is common to both tables. To join a table or field to another, you do not need a special license, simply right click the layer you want to join a table to, and in the drop down select "Joins and Relates". From here, another drop down menu will appear where you can select from a number of options, but most frequently will choose, "Join". If you later want to remove a join, follow the same steps, and simply select "Remove Join". This will only remove the fields that you added previously, it will not remove the pre-existing attribute table data. The tool allows for two different spaces for the user to define which field the join is based on, not which field you want added. This is because depending on your attribute tables, there could be a common field between the two tables you are joining but they may not share the same titles.

For more in-depth information about each operation listed please see the link that corresponds to the operation number.

1. http://gis.stackexchange.com/questions/106883/measuring-area-of-raster-classes
2. http://desktop.arcgis.com/en/arcmap/10.3/tools/spatial-analyst-toolbox/an-overview-of-the-zonal-tools.htm; http://resources.arcgis.com/de/communities/analysis/017z00000013000000.htm
3. http://desktop.arcgis.com/en/arcmap/10.3/manage-data/tables/calculating-area-length-and-other-geometric-properties.htm
4. http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Reclassify/009z000000sr000000/
5. http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//001200000008000000
6. http://desktop.arcgis.com/en/arcmap/latest/tools/analysis-toolbox/buffer.htm
7. https://blogs.esri.com/esri/supportcenter/2013/08/23/when-to-use-the-define-projection-tool-and-the-project-tool-2/; http://desktop.arcgis.com/en/arcmap/10.3/tools/data-management-toolbox/project.htm
8. http://desktop.arcgis.com/en/arcmap/latest/manage-data/raster-and-images/what-is-the-image-analysis-window.htm
9. http://desktop.arcgis.com/en/arcmap/latest/tools/analysis-toolbox/clip.htm
10. http://desktop.arcgis.com/en/arcmap/latest/tools/data-management-toolbox/mosaic-to-new-raster.htm
11. http://desktop.arcgis.com/en/arcmap/10.3/analyze/executing-tools/a-quick-tour-of-batch-processing.htm
12. http://desktop.arcgis.com/en/arcmap/10.3/manage-data/tables/essentials-of-joining-tables.htm

Dataset Source Information

Below is a table that details the year of which dataset was used for the counties in the states of Washington D.C., Maryland, New York, and West Virginia as completed by the Chesapeake Conservancy.

The public sources utilized by the University of Vermont Spatial Analysis Lab for Delaware and Pennsylvania[1] are listed below in Table 2 with metadata[3] also available online. WorldView Solutions Inc. was responsible for Virginia[2]. If you have questions about either organizations source data please see the links below to direct your questions, or reach out to us and we will put you in contact with the appropriate person.

[1]. https://www.uvm.edu/rsenr/sal/?Page=pgAbout/contact.html&SM=pgAbout/menuAboutSub.html
[2]. http://vgin.maps.arcgis.com/home/item.html?id=6ae731623ff847df91df767877db0eae
[3]. http://www.pasda.psu.edu/uci/FullMetadataDisplay.aspx?file=landcover_2013_pennsylvania_chb_drb.xml

Table 1: Source Data Information for Washington, D.C., MD, NY, and WV

Location	LiDAR Year	NAIP Year	Orthoimagery Year	County Planimetric Datasets Used in Classification	Other Supporting Data
Washington D.C.					
D.C.	2014	2013	Not Classified	Building_Footprints.shp; Impervious_Surface_2010.shp; Roads_All_WGS.shp	National Wetlands Inventory with MD Edits
Source:	http://opendata.dc.gov/datasets?keyword=imagery	http://opendata.dc.gov/	http://opendata.dc.gov/		
Maryland	**LiDAR Year**	**NAIP Year**	**Orthoimagery Year**	**County Planimetric Datasets Used in Classification**	**Other Supporting Data**
Allegany	2012 (NRCS; USGS; FEMA: Region 3 - Allegany, Frederick, and Washington Co.)	2013	Not Classified	Buildings; Driveways, paved and unpaved; Roads, paved and unpaved; Parking, paved and unpaved	National Wetland Inventory with MD Edits for Marine Wetlands
Anne Arundel	2011 (Anne Arundel Co.); 2004 (Statewide)	2013	Not Classified	2014 Impervious Surface	National Wetland Inventory with MD Edits for Marine Wetlands
Baltimore City	2008 (Baltimore City; 2015 MD/PA Sandy Supplemental LiDAR was not available at the time)	2013	2014	Buildings.shp; ftrtopoly.shp (Transportation)	National Wetlands Inventory with MD Edits
Baltimore County	2015 (Baltimore Co.)	2013	Not Classified	LANDUSE_Impervious2014 (for buildings and roads/other impervious), HydrologyPolygons.shp (for wetlands and docks/piers/dams)	National Wetland Inventory with MD Edits for Marine Wetlands
Calvert	2011 (Calvert Co.)	2013	Not Classified	Buildings_2011.shp; Structure_Poly_2011.shp; SWMP_2011.shp; Transportation_Poly_2011.shp	National Wetlands Inventory with MD Edits
Caroline	2006 (NRCS; USGS: Hurricane Sandy Supplemtnal LiDAR - Caroline, Dorchester was not available at the time)	2013	Not Classified	Buildings_addressable.shp; Buildings_nonaddressable.shp; Caroline MD drivewayBuff.shp; Caroline_MD_Parking_Lots.shp; RoadsBuff.shp	National Wetlands Inventory with MD Edits

Carroll	2015 (USGS: MD/PA Sandy Supplemental LiDAR - Baltimore City, Kent, Talbot, Carroll)	2013	Not Classified	Buildings; LU_impervious surfaces	National Wetland Inventory with MD Edits for Marine Wetlands
Cecil	2013 (Cecil Co.; USGS)	2013	2013	Buildings_edits.shp; Buffered centerlines	National Wetland Inventory with MD Edits for Marine Wetlands
Charles	2004 (2014 was unavailable at time of classification)	2013	Not Classified	CharlesCountyImpervious_2013.gdb (AthleticFields; Buildings; ParkingAreas; Patios; Pools; Roads; Sidewalks)	National Wetlands Inventory with MD Edits
Dorchester	2013 (USGS: Hurricane Sandy Supplemental LiDAR - Caroline, Dorchester)	2013	Not Classified	Buildings.shp; Buildings_Secondary.shp; ImperviousSurfaces.shp; PavementSurface.shp	National Wetlands Inventory with MD Edits
Frederick	2012 (NRCS; USGS; FEMA: Region 3 - Allegany, Frederick, and Washington Co.)	2013	Not Classified	Buildings; Edge of pavement	National Wetland Inventory with MD Edits for Marine Wetlands
Garrett	2015 (Garrett Co.)	2013	2014	Building_Footprints.shp	National Wetland Inventory with MD Edits for Marine Wetlands; NAVTEQ roads; MD Statewide Roads Dataset
Harford	2013 (Harford Co.)	2013	Not Classified	Buildings_2013; Roads_2013; ImperviousSurfaces	National Wetland Inventory with MD Edits for Marine Wetlands
Howard	2011 (Howard Co.)	2013	Not Classified	MDE (Buildings, Impervious: bridge decks, parking lots, sidewalks, pools, edge of pavement, pathways, paved driveways with edits); SWM ponds; railroads	National Wetland Inventory with MD Edits for Marine Wetlands
Kent	2015 (USGS: MD/PA Sandy Supplemental LiDAR - Baltimore City, Kent, Talbot, Carroll)	2013	2013	Bridge_deck; Buildings-addressable; Centerlines_Roads; Out (buildings data); Secondary-Roads	National Wetland Inventory with MD Edits for Marine Wetlands
Montgomery	2013 (Montgomery Co.)	2013	Not Classified	Trans_poly (Transportation); Buildings.shp; Parking.shp; Sidewalks.shp; Road_poly; bridges_poly	National Wetlands Inventory with MD Edits
Prince George's	2014 (USGS: Hurricane Sandy Supplemental LiDAR - Charles, Prince George's, St. Mary's)	2013	2014	Impervious_Surface_2014_Py.shp; Impervious_Surface_2009_Py.shp; Transportation_2009_Py.shp; Building_2009_Py.shp	National Wetlands Inventory with MD Edits
Queen Anne's	2013 (Queen Anne's Co.)	2013	Not Classified	CW_Impervious_Cover.shp	National Wetlands Inventory with MD Edits
Somerset	2012 (USGS; NRCS Maryland LiDAR - Somerset, Wicomico)	2013	2013	Bldg_poly.shp	MD Statewide Roads Dataset; Tigerline Road Centerlines; National Wetlands Inventory with MD Edits
St. Mary's	2014 (USGS: Hurricane Sandy Supplemental LiDAR - Charles, Prince George's, St. Mary's)	2013	2013	2007BuildingOutlines.shp; Smc_Parking_Lots.shp; Smc_SMC_Road_Surfaces.shp	National Wetlands Inventory with MD Edits
Talbot	2015 (USGS: MD/PA Sandy Supplemental LiDAR - Baltimore City,	2013	Not Classified	MDE (Buildings, Impervious: Airport, pools, and centerline buffers with edits)	National Wetland Inventory with MD Edits for Marine Wetlands

	Kent, Talbot, Carroll)				
Washington	N/A at the time	2013	2014	BLDG_Bldg; Driveway_Paved; Driveway_Unpaved; Parking_Paved; Parking_Unpaved; Roads_Paved; Roads_Unpaved	National Wetlands Inventory with MD Edits
Wicomico	2002 (NRCS); 2003 (USGS; NRCS); 2012 (USGS; NRCS Maryland LiDAR - Somerset, Wicomico)	2013	2013	Wicomico_SDE_RoadBed_4_12_2012; Wicomico_SDE_Buildings	National Wetlands Inventory with MD Edits
Worcester	2002 (NRCS); 2003 (USGS; NRCS); 2011 (NRCS; USGS: VA FEMA LiDAR - Coastal Worcester and Pocomoke and Atlantic Coastal Watersheds in Maryland)	2013	2013	Worc_buildings	MD Statewide Roads Dataset; National Wetlands Inventory with MD Edits
Source:	http://imap.maryland.gov/Pages/lidar-metadata.aspx	http://imap.maryland.gov/Pages/data.aspx	http://imap.maryland.gov/Pages/data.aspx		
New York	LiDAR Year	NAIP Year	Orthoimagery Year	County Planimetric Datasets Used in Classification	Other Supporting Data
Broome	2007 (FEMA, Susquehanna Basin)	2013	2010, 2014, 2015	Building footprints; Broome County Road Centerlines	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Chemung	2002; 2005 (FEMA, Chemung Watershed)	2013	2014, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Chenango	2007 (FEMA, Susquehanna Basin)	2013	2011, 2012, 2013, 2014, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Delaware	2007 (FEMA, Delaware Co.)	2013	2009, 2010, 2012, 2014	Building footprints; Delaware County County Road Centerlines	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Herkimer	N/A	2013	2013, 2014	Herkimer County Road Centerlines	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Oneida	N/A at the time	2013	2013, 2014	Building footprints; Oneida County Road Centerlines	SAM_Master_Statewide_Database.gdb (address points);

					StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Otsego	N/A at the time	2013	2010, 2012, 2014	Building footprints; Otsego County address points	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Schoharie	2014 (USGS, Schoharie/Montgomery Co.)	2013	2010, 2014	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Tioga	2007 (FEMA, Susquehanna Basin)	2013	2014, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Allegany	N/A	2013	2012, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Cayuga	N/A at the time	2013	2012, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Cortland	Partial 2007 (FEMA, Susquehanna Basin)	2013	2012, 2013, 2014, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Livingston	N/A at the time	2013	2012, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Madison	Partial 2007 (FEMA, Susquehanna Basin)	2013	2013, 2014, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Onondaga	Partial 2005 (Onondaga Co)	2013	2012, 2013, 2015	Building footprints;	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road

					Centerlines; National Wetlands Inventory
Ontario	N/A at the time	2013	2010, 2015	Building footprints;	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Schuyler	Partial 2012 (FEMA, Seneca Watershed)	2013	2011, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Steuben	Partial 2012 (FEMA, Seneca Watershed)	2013	2012, 2014, 2015	Building footprints;	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Tompkins	2007 (FEMA, Susquehanna Basin), 2008 (Tompkins Co.)	2013	2012, 2014, 2015	Building footprints;	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Yates	Partial 2012 (FEMA, Seneca Watershed)	2013	2011, 2012, 2015	N/A	SAM_Master_Statewide_Database.gdb (address points); StreetSegment_Public.shp (road centerlines); Tigerline Road Centerlines; National Wetlands Inventory
Source:	http://gis.ny.gov/elevation/lidar-coverage.htm	http://gis.ny.gov/	http://gis.ny.gov/		
West Virginia	**LiDAR Year**	**NAIP Year**	**Orthoimagery Year**	**County Planimetric Datasets Used in Classification**	**Other Supporting Data**
Berkeley	2012 (FEMA Region 3 FY12 LiDAR)	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory; landcover_2011_berkeleycounty.img
Grant	N/A	2013	2015	N/A	NAVTEQ roads; National Wetlands Inventory
Greenbrier	N/A	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory
Hampshire	N/A	2013	2015	N/A	NAVTEQ roads; National Wetlands Inventory
Hardy	N/A	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory
Jefferson	2012 (FEMA Region 3 FY12 LiDAR)	2013	2015	BldgFootprints_2016; DrivewaysParkingLots_2016; Roads_2016	NAVTEQ roads; National Wetlands Inventory
Mineral	N/A	2013	2015	N/A	NAVTEQ roads; National Wetlands Inventory

Monroe	N/A	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory
Morgan	2012 (FEMA Region 3 FY12 LiDAR)	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory
Pendleton	N/A	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory
Pocahontas	N/A	2013	2015	N/A	NAVTEQ roads; National Wetlands Inventory
Preston	N/A	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory
Randolph	N/A	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory
Tucker	N/A	2013	2011, 2012	N/A	NAVTEQ roads; National Wetlands Inventory
Source:	http://wvgis.wvu.edu/data/data.php	http://wvgis.wvu.edu/data/data.php	http://wvgis.wvu.edu/data/data.php		

Table 2: PA and DE Data Sources used by University of Vermont Spatial Analysis Lab

Pennsylvania	**LiDAR**	**NAIP**	**Orthoimagery**	**County Planimetric Datasets Used in Classification**	**Other Supporting Data**
Adams	2007	2013	2007	List pending	List pending
Allegheny	2006	2013	2006	List pending	List pending
Armstrong	2006	2013	2006	List pending	List pending
Beaver	2006	2013	2006	List pending	List pending
Bedford	2007	2013	2007	List pending	List pending
Berks	2008	2013	2008	List pending	List pending
Blair	2006	2013	2006	List pending	List pending
Bradford	2008	2013	2008	List pending	List pending
Bucks	2008	2013	2008	List pending	List pending
Butler	2006	2013	2006	List pending	List pending
Cambria	2006	2013	2006	List pending	List pending
Cameron	2006	2013	2006	List pending	List pending
Carbon	2008	2013	2008	List pending	List pending
Centre	2006	2013	2006	List pending	List pending
Chester	2008	2013	2008	List pending	List pending
Clarion	2006	2013	2006	List pending	List pending
Clearfield	2006	2013	2006	List pending	List pending
Clinton	2007	2013	2005	List pending	List pending
Columbia	2008	2013	2008	List pending	List pending

Crawford	2007	2013	2005	List pending	List pending
Cumberland	2007	2013	2007	List pending	List pending
Dauphin	2008	2013	2008	List pending	List pending
Delaware	2008	2013	2008	List pending	List pending
Elk	2006	2013	2006	List pending	List pending
Erie	2007	2013	2005	List pending	List pending
Fayette	2006	2013	2006	List pending	List pending
Forest	2006	2013	2006	List pending	List pending
Franklin	2007	2013	2007	List pending	List pending
Fulton	2007	2013	2007	List pending	List pending
Greene	2006	2013	2006	List pending	List pending
Huntingdon	2007	2013	2007	List pending	List pending
Indiana	2006	2013	2006	List pending	List pending
Jefferson	2006	2013	2006	List pending	List pending
Juniata	2007	2013	2007	List pending	List pending
Lackawanna	2007	2013	2008	List pending	List pending
Lancaster	2008	2013	2008	List pending	List pending
Lawrence	2006	2013	2006	List pending	List pending
Lebanon	2008	2013	2008	List pending	List pending
Lehigh	2008	2013	2008	List pending	List pending
Luzerne	2006	2013	2008	List pending	List pending
Lycoming	2007	2013	2005	List pending	List pending
McKean	2007	2013	2005	List pending	List pending
Mercer	2006	2013	2006	List pending	List pending
Mifflin	2007	2013	2007	List pending	List pending
Monroe	2008	2013	2008	List pending	List pending
Montgomery	2008	2013	2008	List pending	List pending
Montour	2008	2013	2008	List pending	List pending
Northampton	2008	2013	2008	List pending	List pending
Northumberland	2008	2013	2008	List pending	List pending
Perry	2007	2013	2007	List pending	List pending
Philadelphia	2008	2013	2008	List pending	List pending
Pike	2008	2013	2008	List pending	List pending

Potter	2007	2013	2005	List pending	List pending
Schuylkill	2008	2013	2008	List pending	List pending
Snyder	2007	2013	2005	List pending	List pending
Somerset	2007	2013	2005	List pending	List pending
Sullivan	2008	2013	2008	List pending	List pending
Susquehanna	2008	2013	2008	List pending	List pending
Tioga	2007	2013	2005	List pending	List pending
Union	2007	2013	2005	List pending	List pending
Venango	2006	2013	2006	List pending	List pending
Warren	2007	2013	2005	List pending	List pending
Washington	2006	2013	2006	List pending	List pending
Wayne	2008	2013	2008	List pending	List pending
Westmoreland	2006	2013	2006	List pending	List pending
Wyoming	2008	2013	2008	List pending	List pending
York	2008	2013	2008	List pending	List pending
Source:	http://www.dcnr.state.pa.us/topogeo/pamap/lidar/index.htm#clouds	http://www.pasda.psu.edu/uci/DataSummary.aspx?dataset=3158	http://www.dcnr.state.pa.us/topogeo/pamap/imagery/index.htm		
Delaware	**LiDAR**	**NAIP**	**Orthoimagery**	**County Planimetric Datasets Used in Classification**	**Other Supporting Data**
New Castle	2014	2013	2014	List pending	List pending
Kent	2014	2013	2014	List pending	List pending
Sussex	2014	2013	2014	List pending	List pending
Source:	https://firstmap.delaware.gov/arcgis/rest/services/Elevation/DE_Lidar_DEM/ImageServer		https://firstmap.delaware.gov/arcgis/rest/services/DE_Imagery/DE_Imagery_Sandy/ImageServer		