- Austin, TX
- Baltimore, MD
- Birmingham, AL
- Brownsville, TX
- Chicago, IL
- Cleveland, OH
- Des Moines, IA
- Durham, NC
- Fresno, CA
- Green Bay, WI
- Los Angeles, CA
- Memphis, TN
- Milwaukee, WI
- Minneapolis, MN
- New Bedford, MA
- New Haven, CT
- New York, NY
- Paterson, NJ
- Philadelphia, PA
- Phoenix, AZ
- Pittsburgh, PA
- Portland, ME
- Portland, OR
- Salt Lake City, UT
- Sonoma County, CA
- St Louis, MO
- Tampa, FL
- Virginia Beach, VA
- Washington, DC
- Woodbine, IA

Meter Scale Urban Land Cover Austin, TX

This EnviroAtlas map shows land cover for the Austin, TX area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, and Agriculture.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

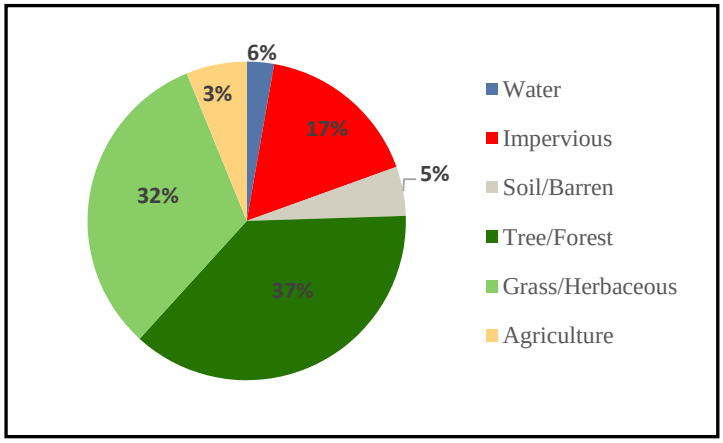

Figure 1: Areal percentage of MULC classes for Austin, TX

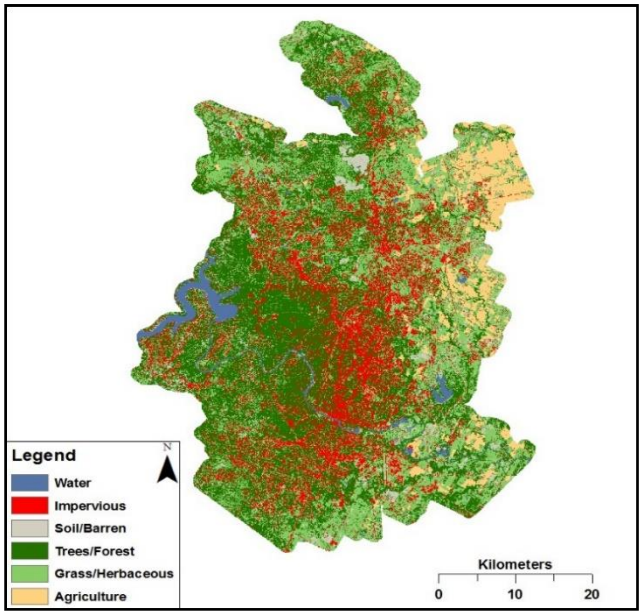

Figure 2: MULC for Austin,

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, and total suspended solids (kg/yr) from filtration by trees

CONTINUED ON BACK

How were the data for this map created?

The MULC data for Austin, Texas were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in May 2010 and LiDAR from August 2007.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were used to map Agriculture.

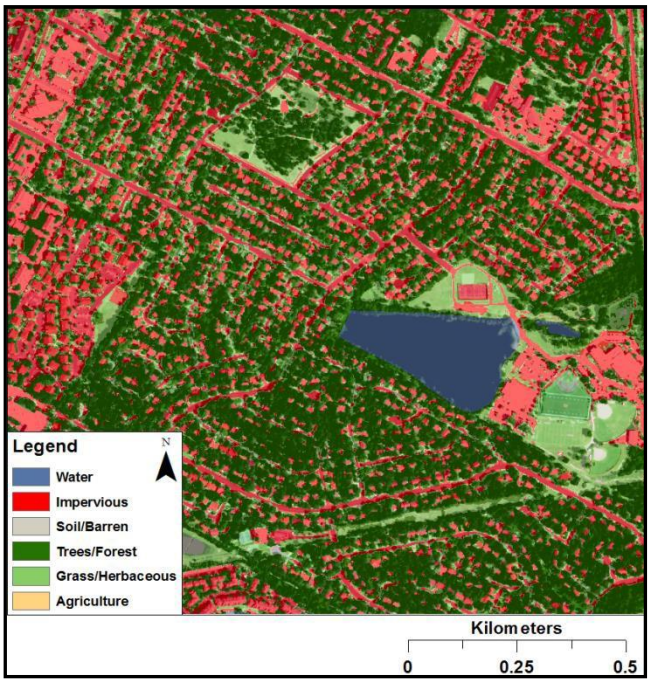

Figure 3: Austin, TX MULC with 40% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 655 photo-interpreted reference points yielded an overall User's Accuracy of about 87 percent for the Austin MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Austin MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Austin, TX area was developed by Charles Rudder, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover Baltimore, MD

This EnviroAtlas map shows land cover for the Baltimore, MD area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Tree, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape require higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

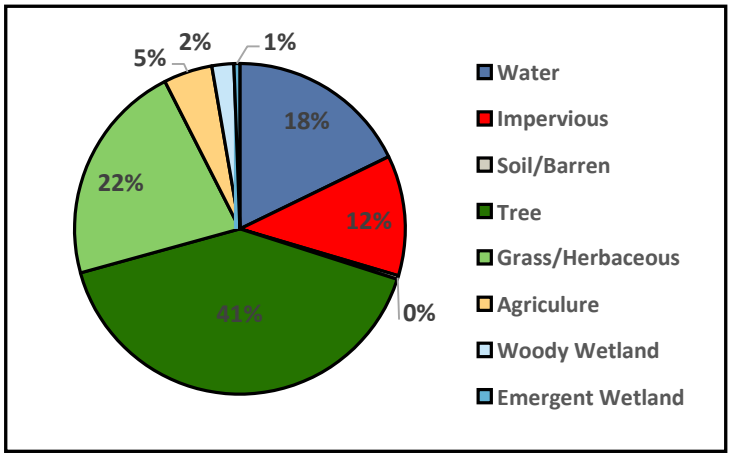

Figure 1: Areal percentage of MULC classes for Baltimore, MD.

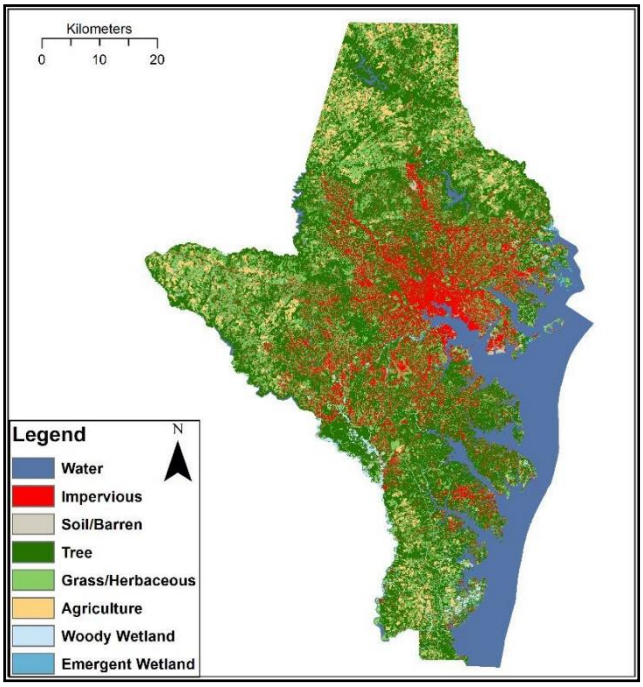

Figure 2: MULC for Baltimore, MD.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, and total suspended solids (kg/yr) from filtration by trees

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How were the data for this map created?

The MULC data for Baltimore, MD were developed by the Chesapeake Conservancy and converted into EnviroAtlas MULC by the EPA.[3] The data were generated from digital image processing and supervised feature extraction of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[4] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in 2013 and LiDAR mostly from 2011 and 2015.

A rule-based feature extraction software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree, and Water. Ancillary data were primarily used to map Wetlands (Woody and Emergent)[5] and Agriculture.

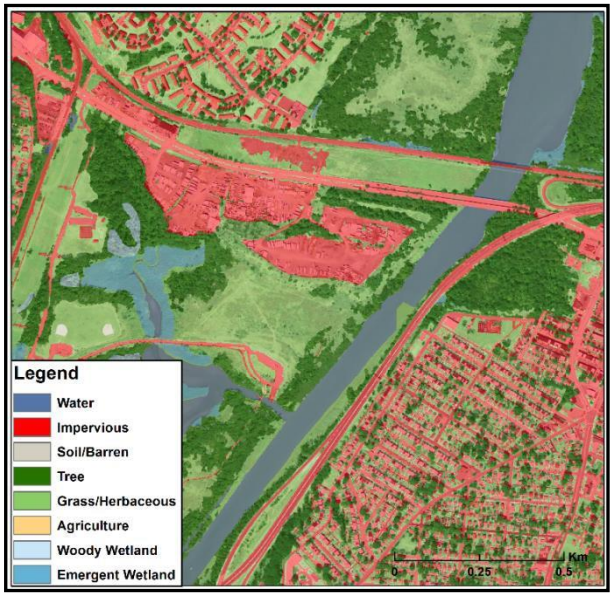

Figure 3: Baltimore MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 687 photo-interpreted reference points yielded an overall User's Accuracy of about 90 percent for the Baltimore MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Baltimore MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Baltimore, MD area were created by the Chesapeake Conservancy, Gwen Oster, EPA ORAU Research Participant, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. Chesapeake Conservancy, 2018. Land Cover Data Project. Accessed March 2018.

4. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

5. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover Birmingham, AL

This EnviroAtlas map shows land cover for the Birmingham, AL area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

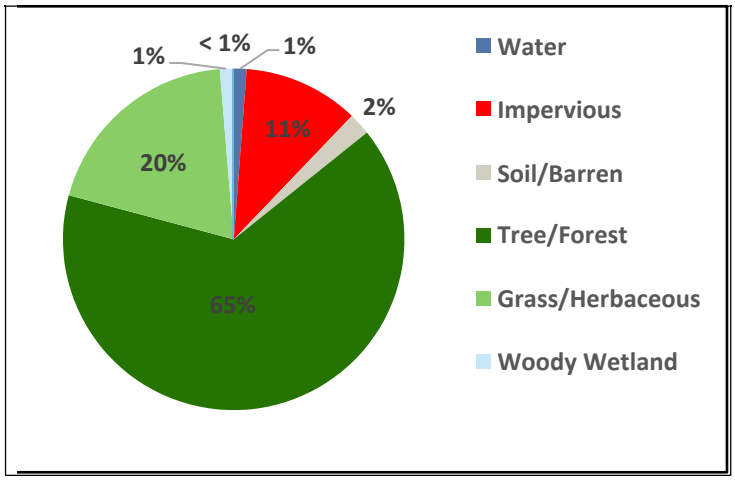

Figure 1: Areal percentage of MULC classes for Birmingham, AL

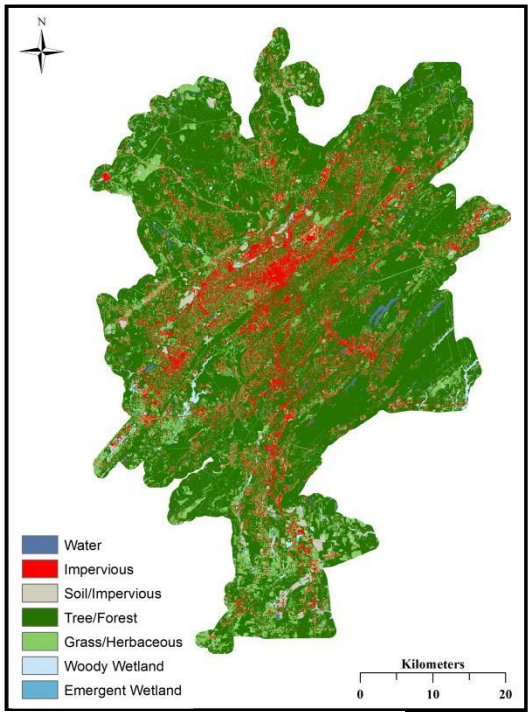

Figure 2. MULC for Birmingham, AL

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorus, and total suspended solids (kg/yr) from filtration by trees.

CONTINUED ON BACK

How were the data for this map created?

The MULC data for Birmingham, AL were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2011 and LiDAR collected in 2010, 2011, and 2013.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map Wetlands (Woody and Emergent).[4]

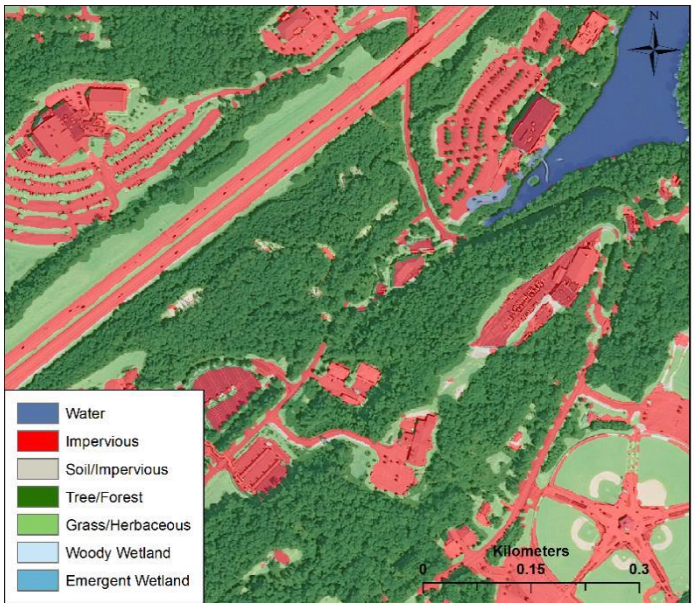

Figure 3: Birmingham MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 595 photo-interpreted reference points yielded an overall User's Accuracy of about 83 percent for the Birmingham MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Birmingham, AL MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Birmingham, AL area was developed by Keith Endres, EPA, Daniel Rosenbaum, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover Brownsville, Texas

This EnviroAtlas map shows land cover for the Brownsville, TX area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Shrub, Agriculture, Orchard, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

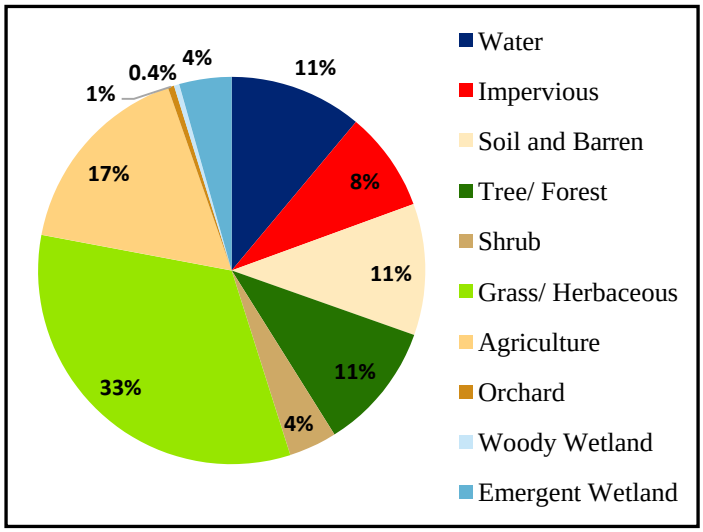

Figure 1: Areal percentage of MULC classes for Brownsville, TX

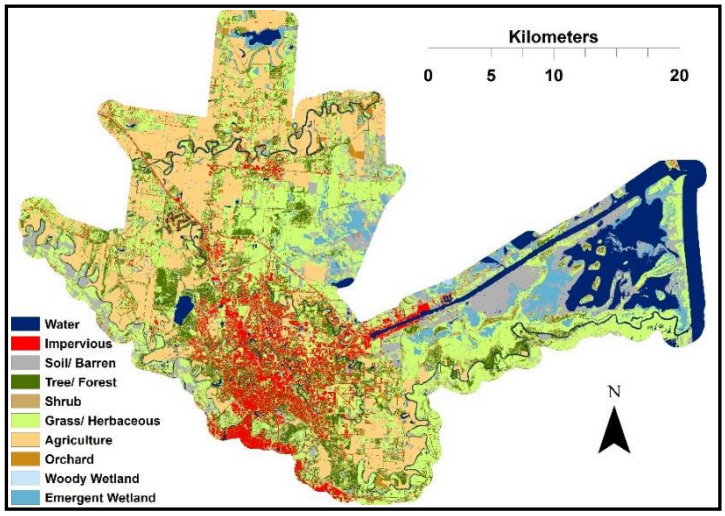

Figure 2: MULC for Brownsville, TX.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Width of road and stream vegetated buffers (m)
- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, and total suspended solids (kg/yr) from filtration by trees

CONTINUED ON BACK

How were the data for this map created?

The MULC data for Brownsville, Texas were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in 2014. LiDAR data were collected in 2006 and 2011 by the International Boundary and Water Commission.

A supervised classification was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. The Shrub class was differentiated from other vegetation classes using LiDAR height data. Ancillary data were used to map four additional classes: Wetlands (Woody and Emergent),[4] Agriculture (row crops), and Orchard.

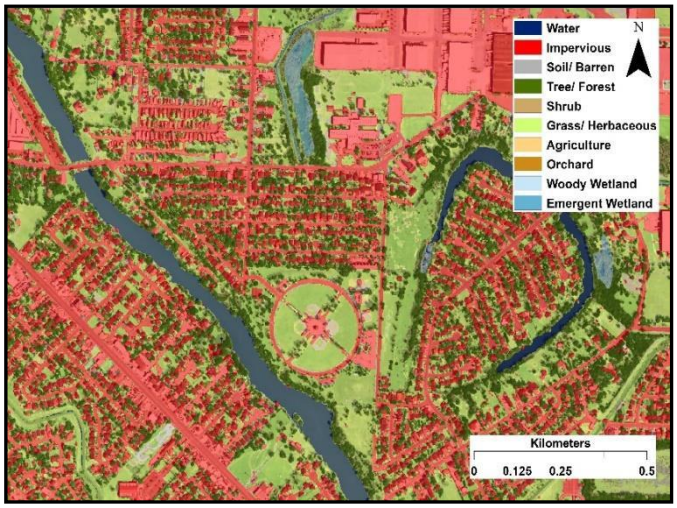

Figure 3: Brownsville MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees,

Manual editing was used to correct misclassifications as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of the Brownsville MULC using 699 photo-interpreted reference points yielded an overall accuracy of 82 percent. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Brownsville MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Brownsville, Texas area were developed by Chelsea Fizer, EPA ORAU Research Participant, Daniel Rosenbaum, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover Chicago, IL

This EnviroAtlas map shows land cover for the Chicago, IL area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland, and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

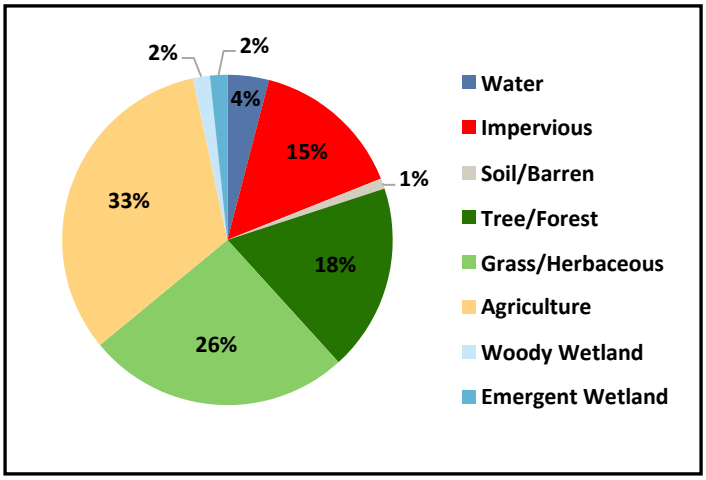

Figure 1: Areal percentage of MULC classes for Chicago, IL.

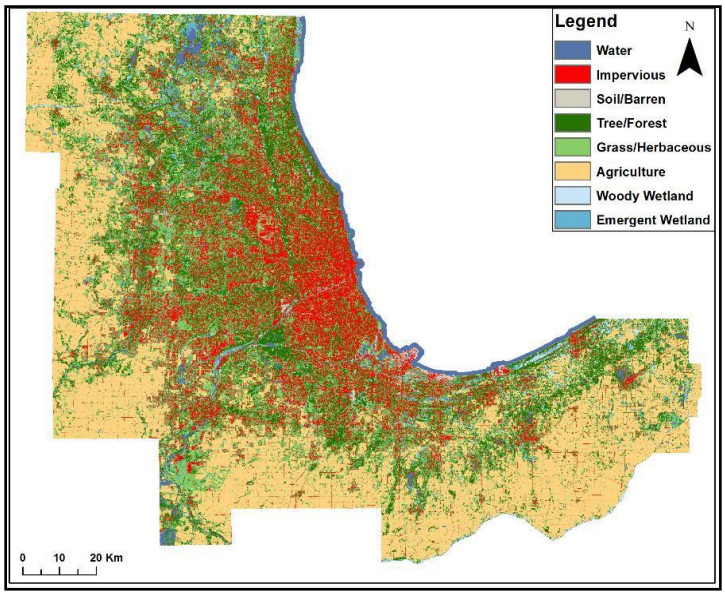

Figure 2: MULC for Chicago, IL.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorus, and total suspended solids (kg/yr) from filtration by trees

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How were the data for this map created?

The MULC data for Chicago, IL were generated from digital image processing and object-based image analysis (OBIA) of aerial photography, LiDAR, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer/fall 2010, 2012, and 2013 and LiDAR data from 2006, 2007, 2008, 2010, 2013 and 2014.

A rule-based feature extraction software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were used to map three additional classes: Wetlands (Woody and Emergent)[4] and Agriculture.

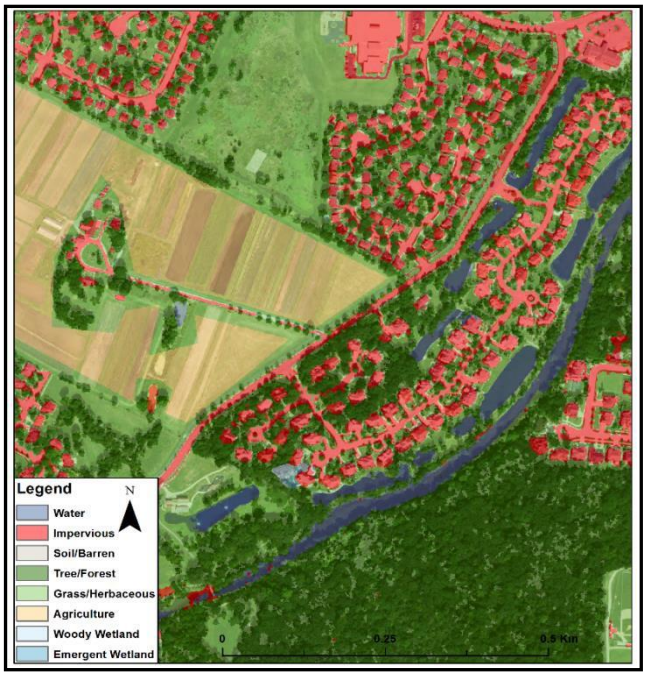

Figure 3: Chicago MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 600 photo-interpreted reference points yielded an overall User's Accuracy of about 81 percent for the Chicago MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Austin MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

The majority of the EnviroAtlas MULC data for the Chicago, IL area were developed by the University of Vermont Spatial Analysis Laboratory (SAL) under the direction of Jarlath O'Neil-Dunne as part of the United States Forest Service Urban Tree Canopy (UTC) assessment program. Daniel Rosenbaum, EPA Student Services Contractor, and Drew Pilant, EPA added wetlands and agriculture classes and assessed accuracy.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover Cleveland, OH

This EnviroAtlas map shows land cover for the Cleveland, Ohio area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Woody Wetland, and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

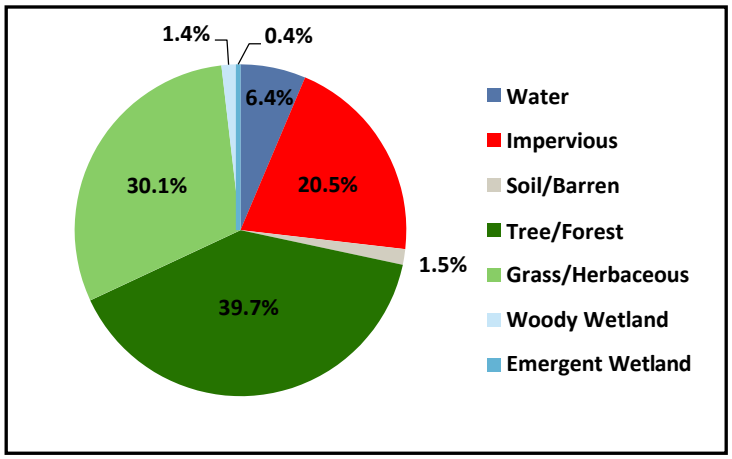

Figure 1: Areal percentage of MULC classes for Cleveland, OH.

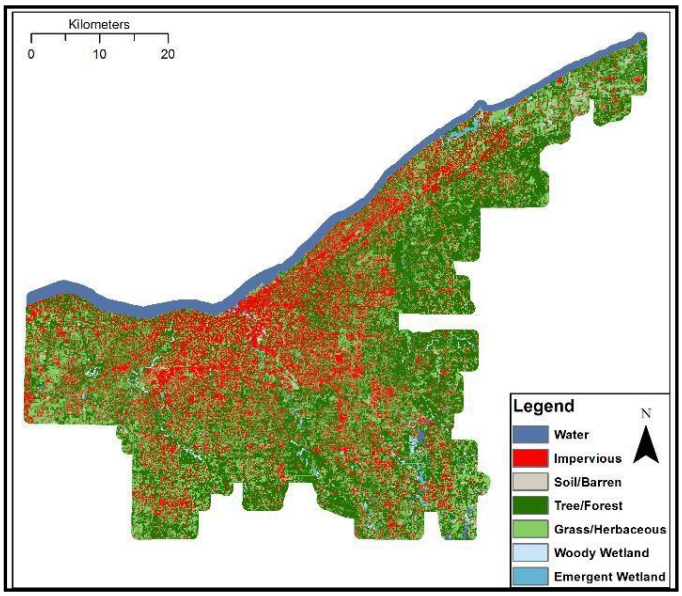

Figure 2: MULC for Cleveland, OH.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above-ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorus, and total suspended solids (kg/yr) from filtration by trees.

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How were the data for this map created?

The MULC data for Cleveland, OH were generated from digital image processing and supervised classification of aerial photography, LiDAR, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP). It includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in fall 2011 and 2013 and LiDAR data from 2006.

A pixel-based classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. National Wetlands Inventory (NWI) data were used to map Woody and Emergent Wetlands.

Figure 3: Cleveland MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 600 photo-interpreted reference points yielded an overall User's Accuracy of about 86 percent for the Cleveland MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Cleveland MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Cleveland, OH area was developed by Daniel Rosenbaum, EPA Student Services Contractor, Drew Pilant, EPA, and the University of Vermont Spatial Analysis Laboratory (SAL) under the direction of Jarlath O'Neil-Dunne. The SAL portion of the land cover was created as part of the United States Forest Service Urban Tree Canopy (UTC) assessment program for Cuyahoga County.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover Des Moines, IA

This EnviroAtlas map shows land cover for the Des Moines, IA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland, and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

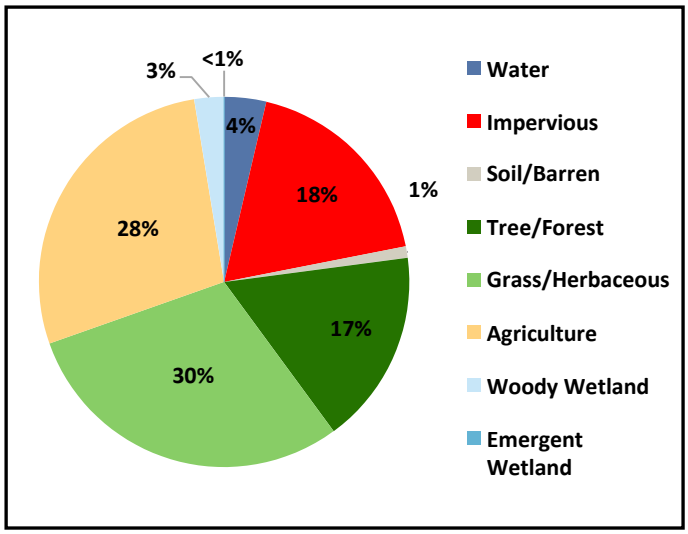

Figure 1: Areal percentage of MULC classes for Des Moines, IA.

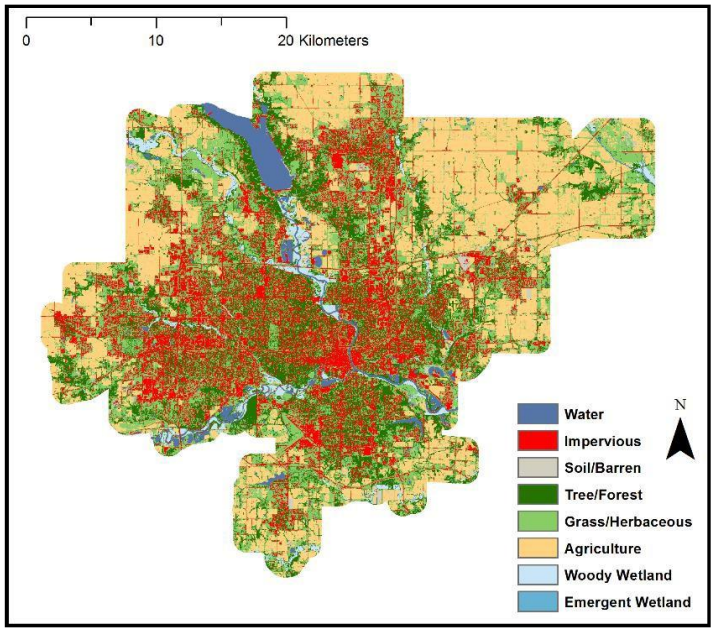

Figure 2: MULC for Des Moines, IA.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorus, and total suspended solids (kg/yr) from filtration by trees.

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How were the data for this map created?

The MULC data for Des Moines, IA were generated from digital image processing and ISODATA classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer/fall 2007-2010 and LiDAR from 2009.

A classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map three additional classes: Woody Wetlands, Emergent Wetlands,[4] and Agriculture.

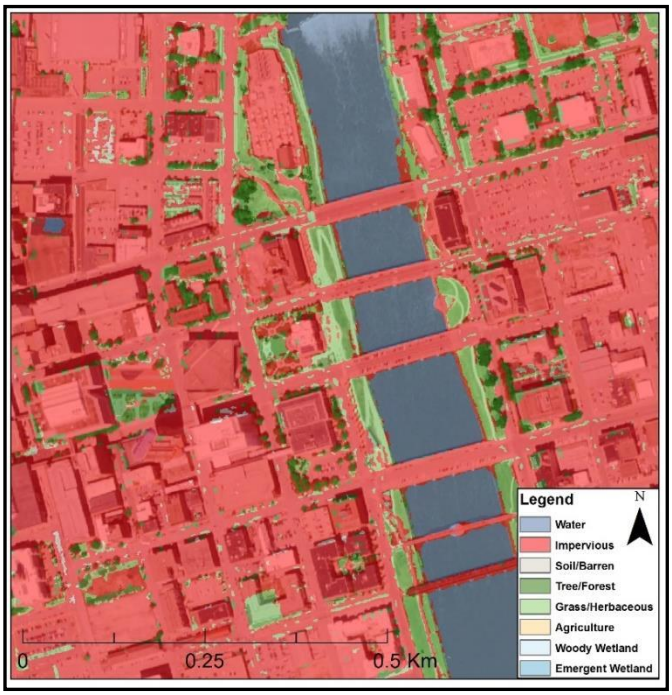

Figure 3: Des Moines MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 655 photo-interpreted reference points yielded an overall User's Accuracy of about 79 percent for the Des Moines MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Des Moines MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Des Moines, IA area were made by modifying existing High Resolution Land Cover (HRLC) data originally created by the Iowa Department of Natural Resources (IDNR). MULC adaptations were made by Charles Rudder, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Durham, NC

This EnviroAtlas map shows land cover for the Durham, NC area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

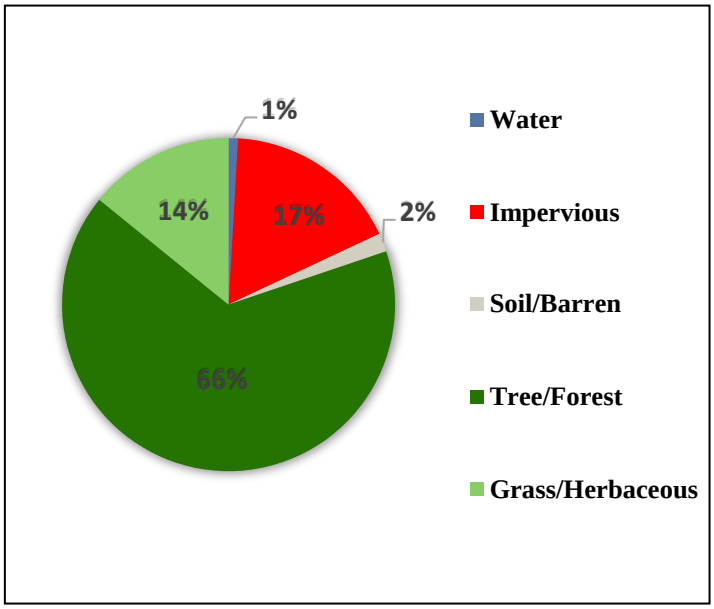

Figure 1: Areal percentage of MULC classes for Durham, NC.

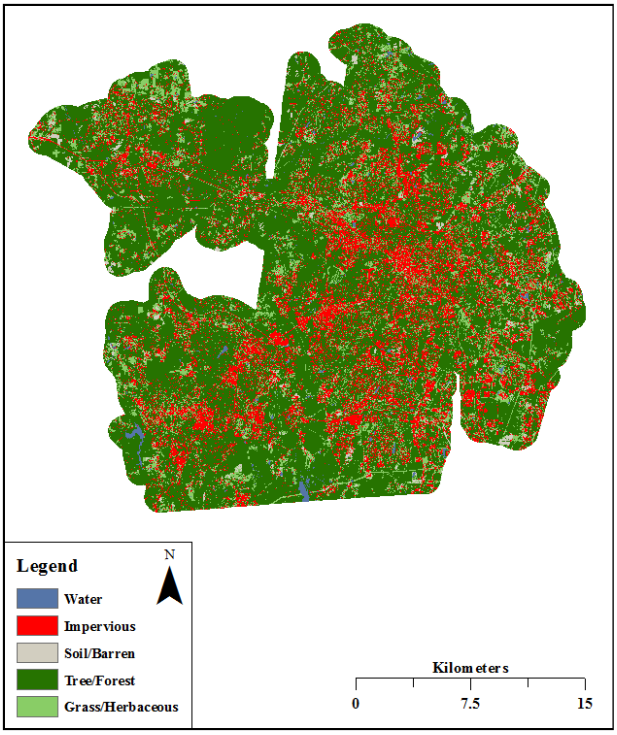

Figure 2: MULC for Durham, NC.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr)

How were the data for this map created?

The MULC data for Durham, NC were generated from digital image processing and supervised classification of aerial photography and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in July 2010.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water.

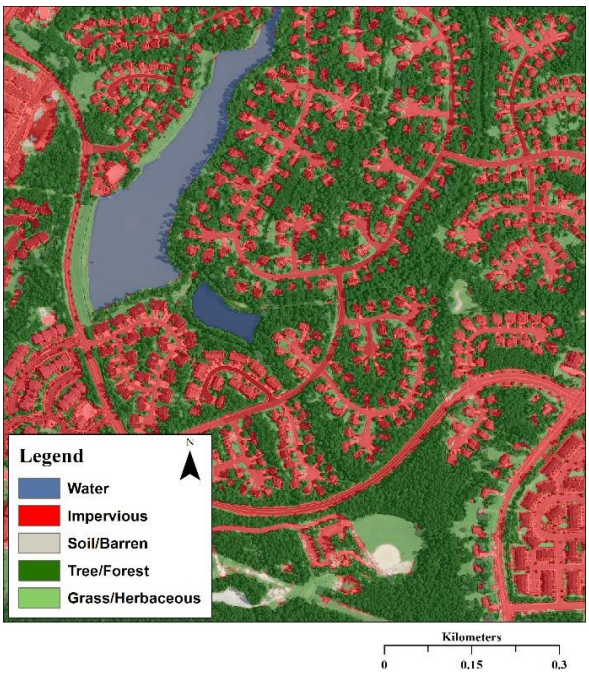

Figure 3: Durham, NC MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 500 photo-interpreted reference points yielded an overall User's Accuracy of about 83 percent for the Durham MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Durham MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Durham, NC area was developed by Jeremy Baynes and Matthew Dannenberg, EPA Student Services Contractors, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Fresno, California

This EnviroAtlas map shows land cover for the Fresno, CA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, and Orchard.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

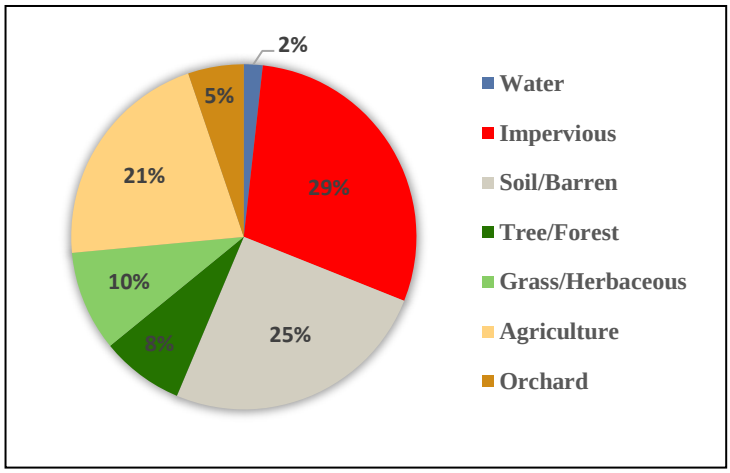

Figure 1: Areal percentage of MULC classes for Fresno, CA.

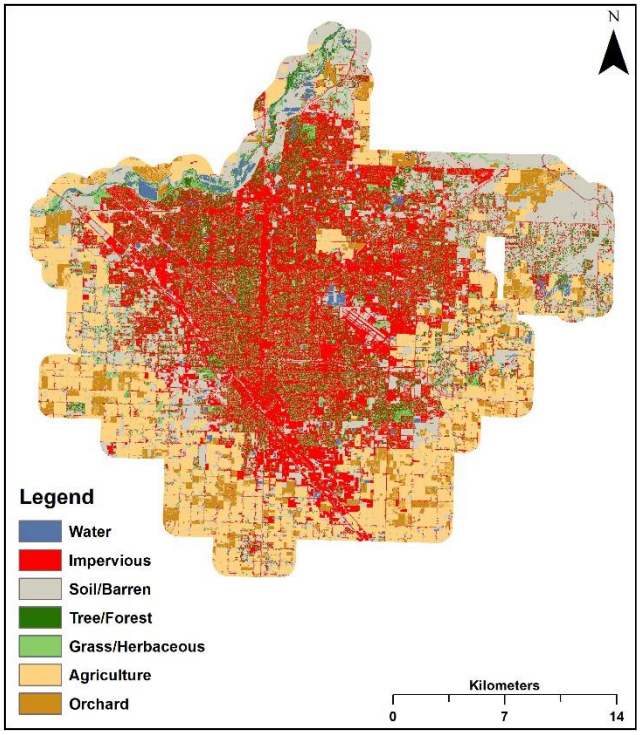

Figure 2: MULC for Fresno, CA.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Fresno, CA were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2010 and LiDAR collected in 2012.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map two additional classes: Agriculture and Orchard. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

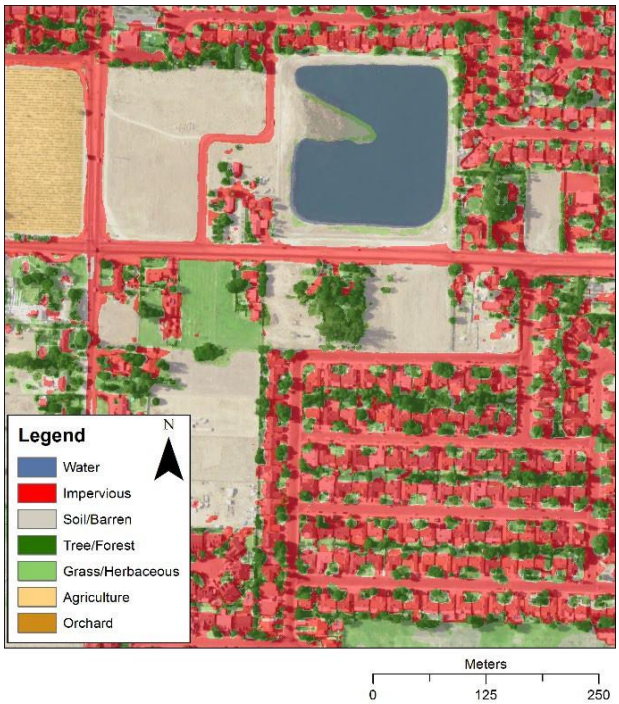

Figure 3: Fresno, CA with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 603 photo-interpreted reference points yielded an overall User's Accuracy of about 81 percent for the Fresno MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Fresno MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Fresno, CA area was developed by Jeremy Baynes, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Green Bay, WI

This EnviroAtlas map shows land cover for the Green Bay, WI area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

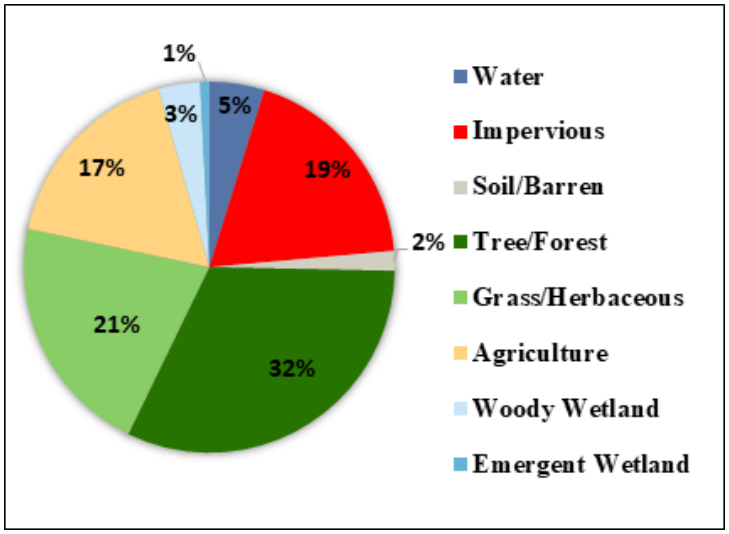

Figure 1: Areal percentage of MULC classes for Green Bay, WI

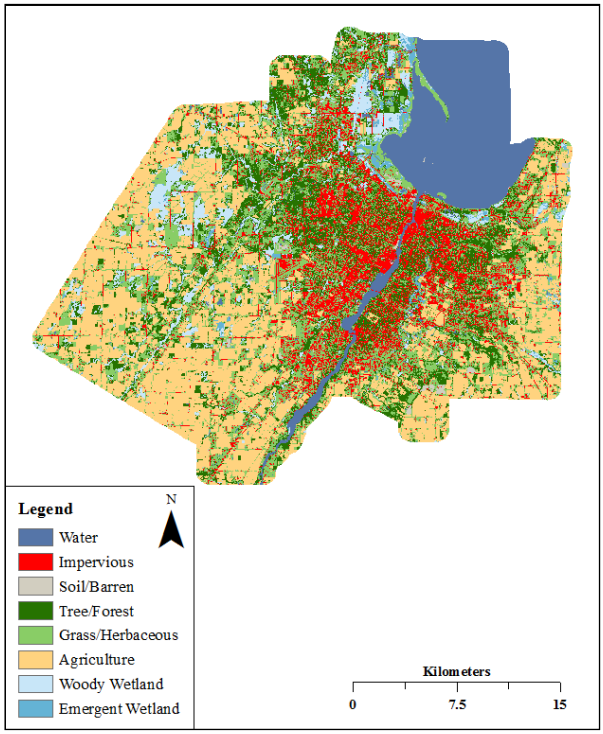

Figure 2: MULC for Green Bay, WI.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Green Bay, WI were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2010 and LiDAR collected in fall 2010.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map three additional classes: Wetlands (Woody and Emergent)[4] and Agriculture. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

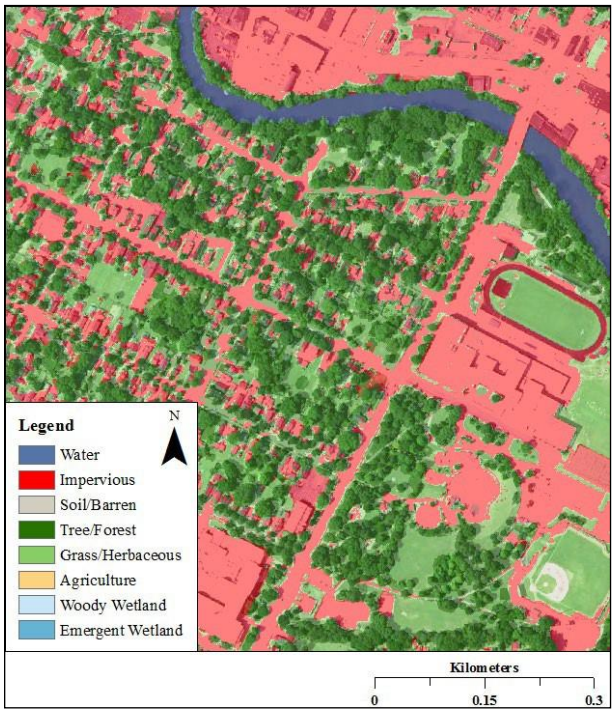

Figure 3: Green Bay, WI with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 614 photo-interpreted reference points yielded an overall User's Accuracy of about 90 percent for the Green Bay MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Green Bay MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Green Bay, WI area was developed by Ben Riegel, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

EnviroAtlas

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Meter Scale Urban Land Cover LA County, CA

This EnviroAtlas map shows land cover for the Los Angeles County, CA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Shrub, Grass and Herbaceous, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

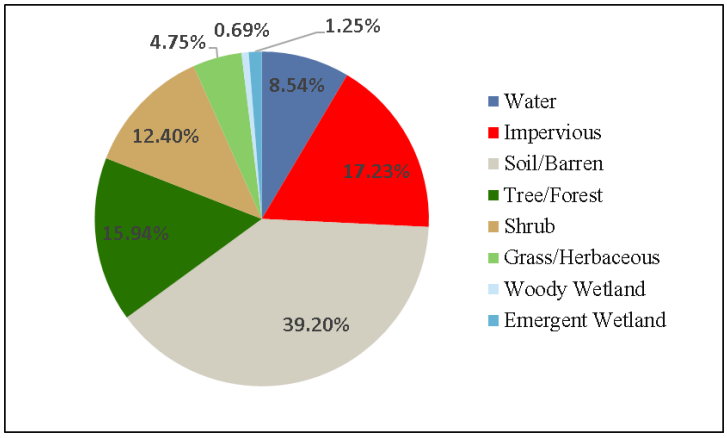

Figure 1: Areal percentage of MULC classes for Los Angeles County, CA.

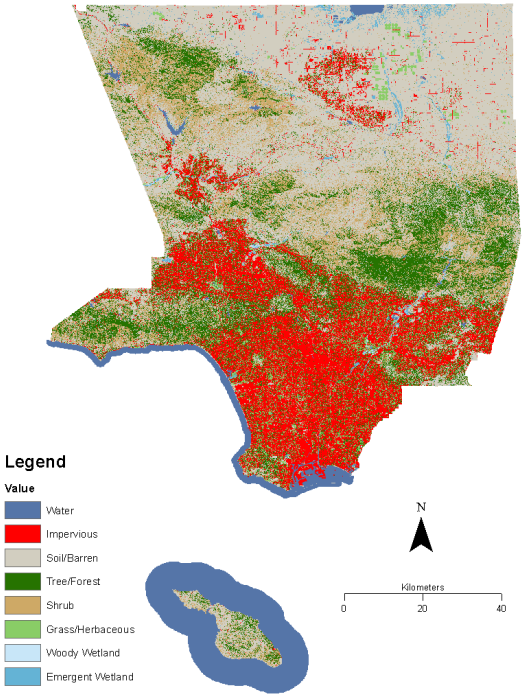

Figure 2: MULC for Los Angeles County, CA.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Los Angeles County, CA were generated from digital image processing and object-based image analysis (OBIA) of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP and LiDAR data collected in 2016 and ortho imagery collected in 2014.

A rule-based feature extraction software was used to identify six common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Shrub, Tree/Forest, and Water. Ancillary data were primarily used to map two additional classes: Wetlands (Woody and Emergent)[4].

Figure 3: Los Angeles County MULC with 50% transparency displayed on top of 2016 aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Supervised classification and manual editing were used to add mapped features (e.g., coastal and solar farm infrastructure) and to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 927 photo-interpreted reference points yielded an overall fuzzy User's Accuracy of about 89 percent for the Los Angeles County MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Los Angeles County MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Development Team for further inquiries.

Acknowledgements

The EnviroAtlas MULC data for the Los Angeles County area was developed by the University of Vermont Spatial Analysis Laboratory (SAL) as part of the United States Forest Service Urban Tree Canopy (UTC) assessment program. Megan Van Fossen and Drew Pilant, EPA, made land cover class corrections and additions and assessed accuracy.

Selected Publications

1. Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. A Land Use and LC Classification System for Use with Remote Sensor Data. Geological Survey Professional Paper 964, U. S. Dept. of Interior.

2. Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345-354.

3. U.S. Department of Agriculture, Farm Service Agency, 2010. Aerial Photography Field Office: U.S. Department of Agriculture Web page. https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/.

4. U.S. Fish and Wildlife Service. National Wetlands Inventory digital data. Website: http://wetlands.fws.gov/.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. Ecosystem Services, 14, 45-55.

Meter Scale Urban Land Cover Memphis, TN

This EnviroAtlas map shows land cover for the Memphis, TN area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland, and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

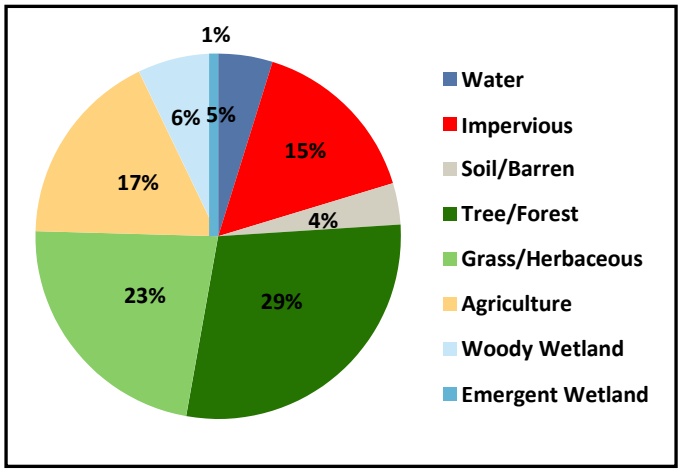

Figure 1: Areal percentage of MULC classes for Memphis, TN.

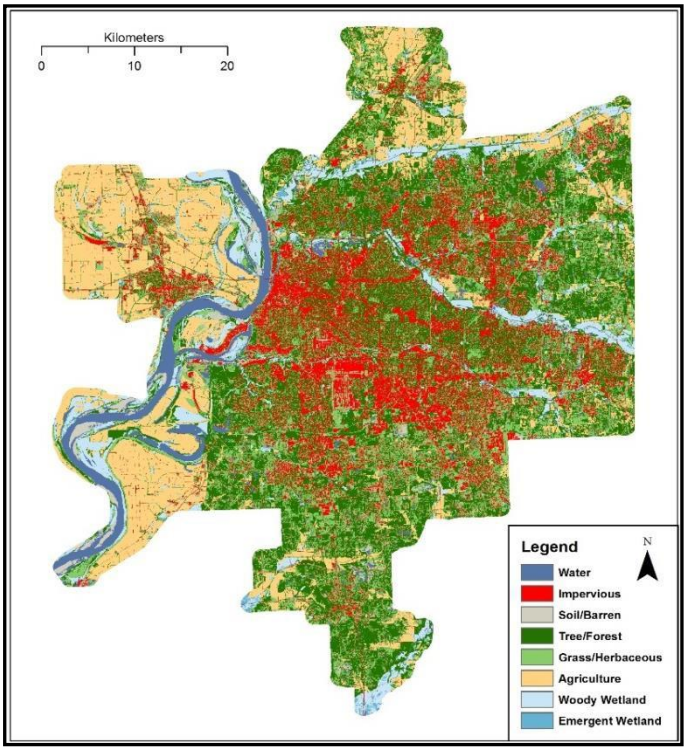

Figure 2: MULC for Memphis, TN.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorus, and total suspended solids (kg/yr) from filtration by trees

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How were the data for this map created?

The MULC data for Memphis, TN were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2012 and 2013 and LiDAR from 2009, 2010, 2011 and 2012.

A classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map three additional classes: Woody Wetlands, Emergent Wetlands,[4] and Agriculture.

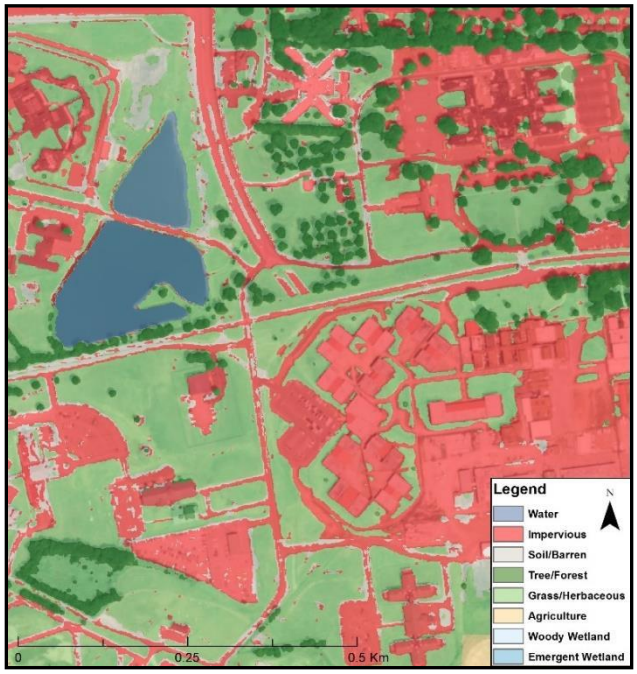

Figure 3: Memphis MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 612 photo-interpreted reference points yielded an overall User's Accuracy of about 87 percent for the Memphis MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Memphis MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Memphis, TN area was developed by Akhilesh Khopkar, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Milwaukee, WI

This EnviroAtlas map shows land cover for the Milwaukee, WI area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

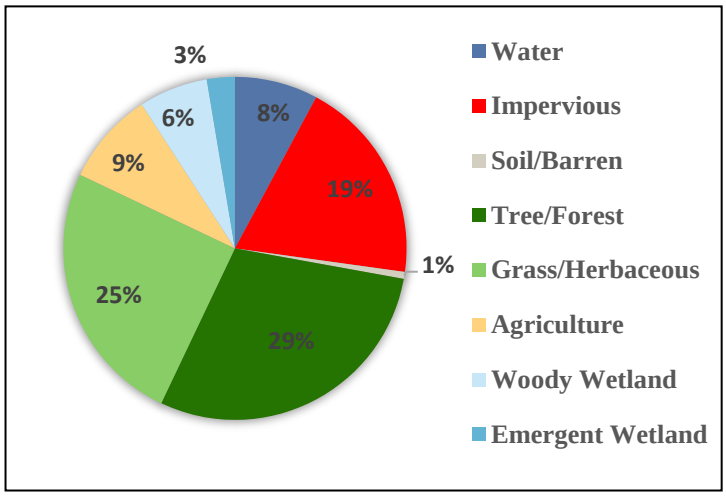

Figure 1: Areal percentage of MULC classes for Milwaukee, WI.

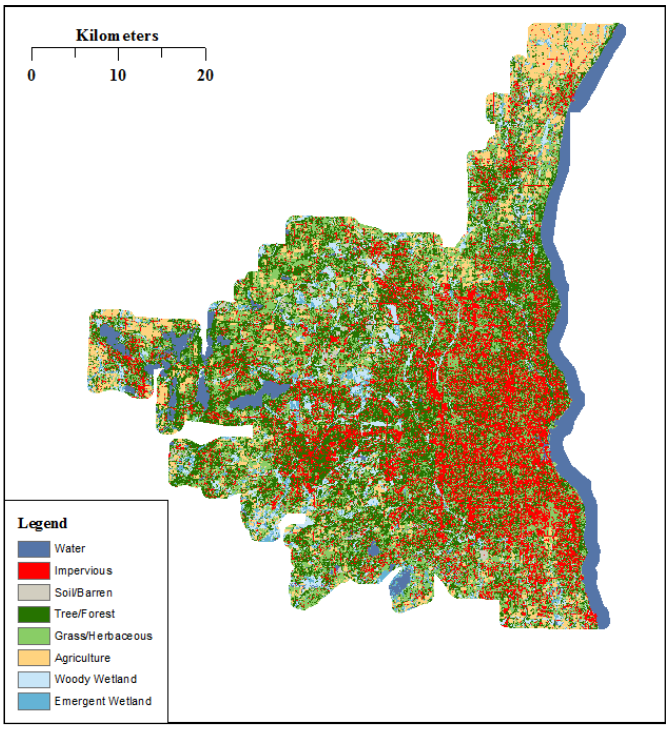

Figure 2: MULC for Milwaukee, WI.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Milwaukee, WI were generated from digital image processing and object-based image analysis (OBIA) of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2010 and LiDAR collected in summer 2010 and spring 2012.

A rule-based feature extraction software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map three additional classes: Wetlands (Woody and Emergent)[4] and Agriculture. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

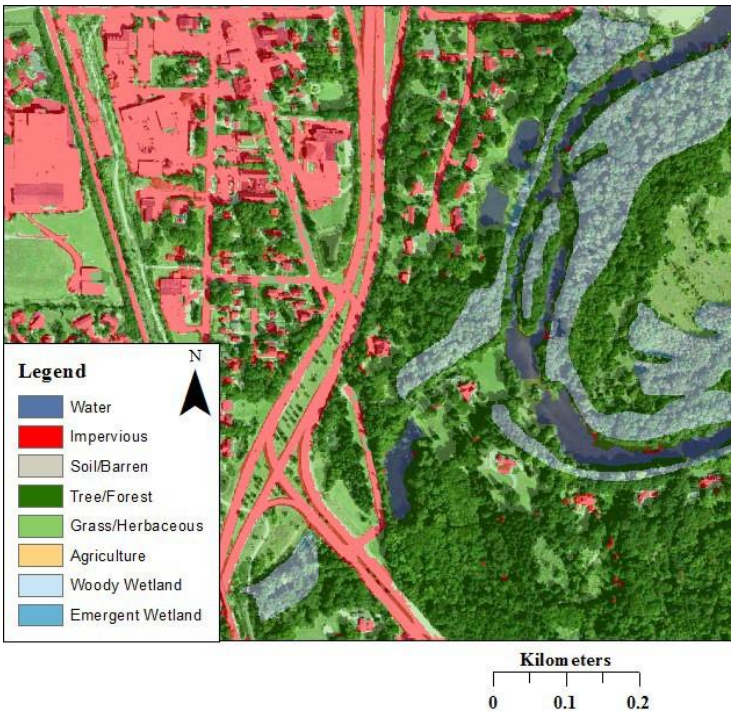

Figure 3: Milwaukee, WI MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 626 photo-interpreted reference points yielded an overall User's Accuracy of about 76 percent for the Milwaukee MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Milwaukee, WI MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Milwaukee, WI area were developed by EPA and Oneida Total Integrated Enterprises (OTIE) and OTIE's subcontractor, the University of Arkansas Center for Advanced Spatial Technologies (CAST). Charles Rudder and Chelsea Fizer, EPA Student Services Contractors and Drew Pilant, EPA created the EPA portion of the data.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover Minneapolis, MN

This EnviroAtlas map shows land cover for the Minneapolis, MN area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

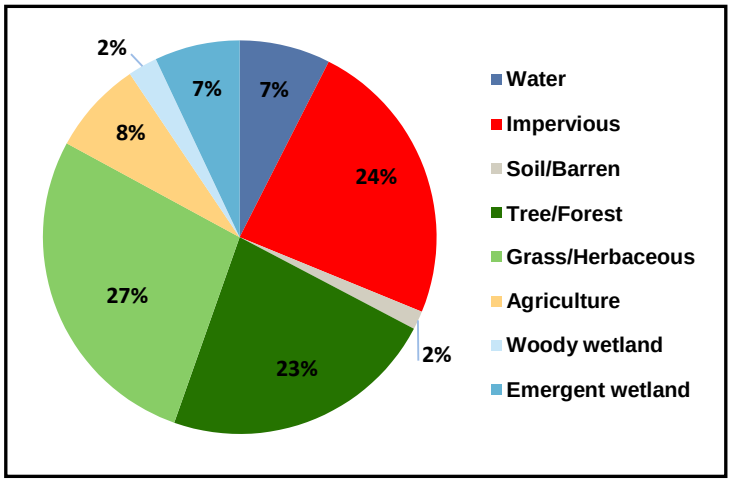

Figure 1: Areal percentage of MULC classes for Minneapolis, MN.

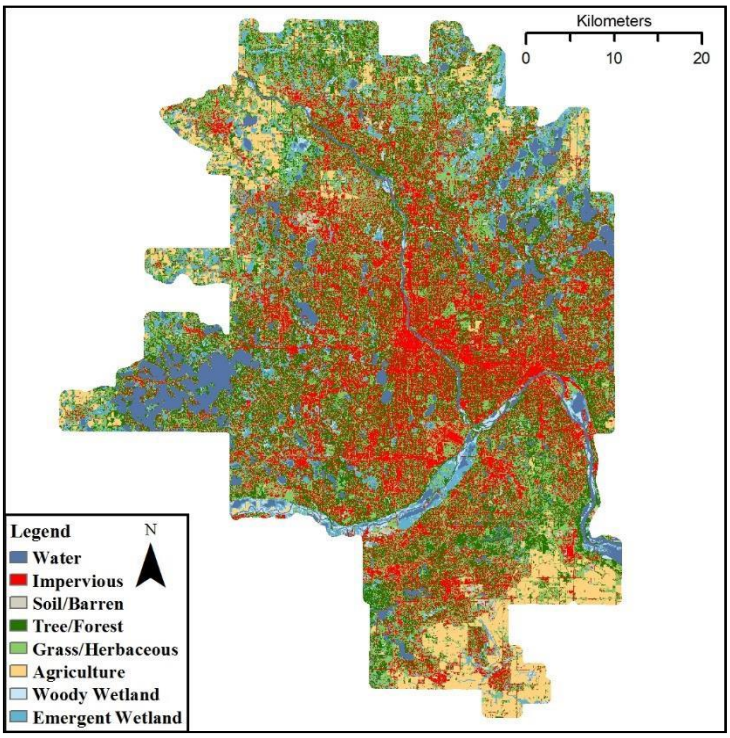

Figure 2: MULC for Minneapolis, MN.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids (kg/yr) from filtration by trees

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How were the data for this map created?

The MULC data for Minneapolis, MN were generated from digital image processing and object-based image analysis (OBIA) of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer/fall 2010 and LiDAR from spring and fall 2011.

A rule-based feature extraction software was used to identify six common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, Shadow, and Water. Ancillary data were primarily used to dissolve shadow into appropriate classes as well as map three additional classes: Wetlands (Woody and Emergent)[4] and Agriculture.

Figure 3: Minneapolis MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 644 photo-interpreted reference points yielded an overall User's Accuracy of about 83 percent for the Minneapolis MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Minneapolis MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Minneapolis, MN area was developed by Akhilesh Khopkar, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover New Bedford, MA

This EnviroAtlas map shows land cover for the New Bedford, MA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

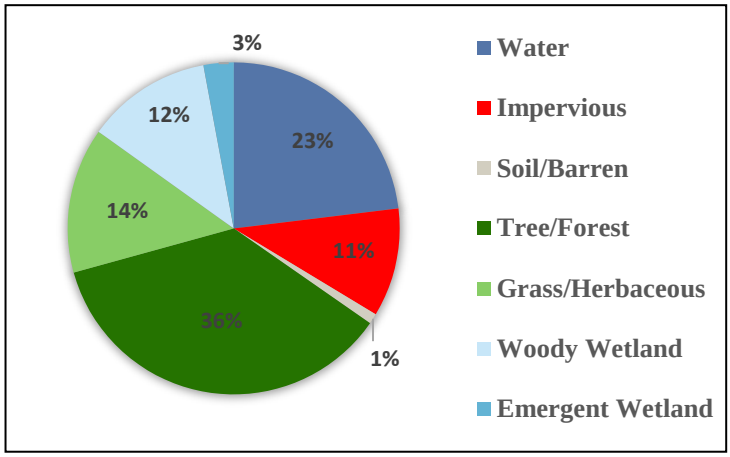

Figure 1: Areal percentage of MULC classes for New Bedford, MA.

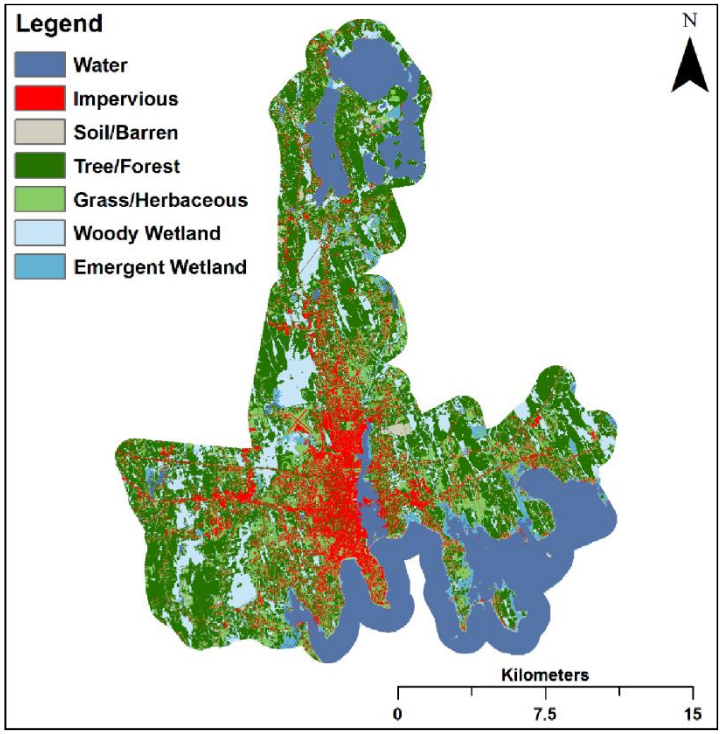

Figure 2: MULC for New Bedford, MA.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for New Bedford, MA were generated from digital image processing and supervised classification of aerial photography and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2010.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map Wetlands (Woody and Emergent)[4]. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

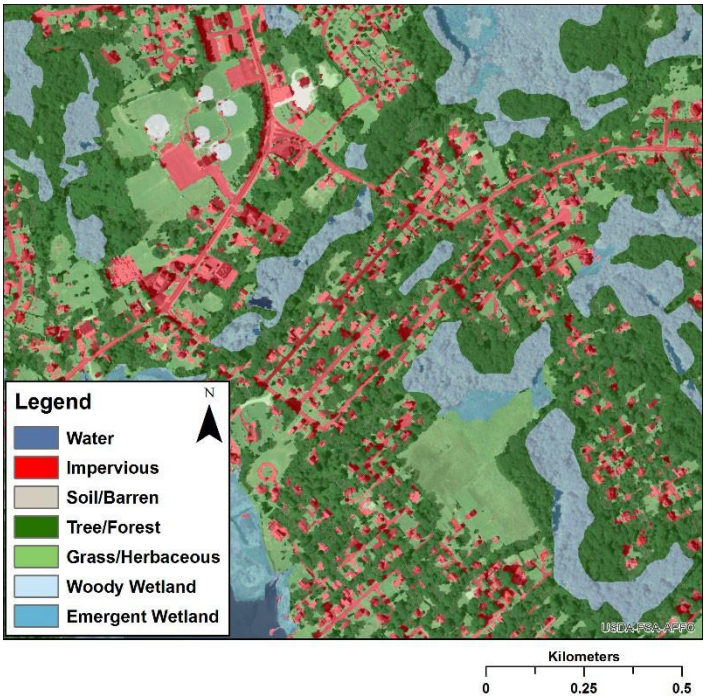

Figure 3: New Bedford MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 545 photo-interpreted reference points yielded an overall User's Accuracy of about 92 percent for the New Bedford MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the New Bedford, MA MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the New Bedford area was developed by Jeremy Baynes, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover New Haven, CT

This EnviroAtlas map shows land cover for the New Haven, CT area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

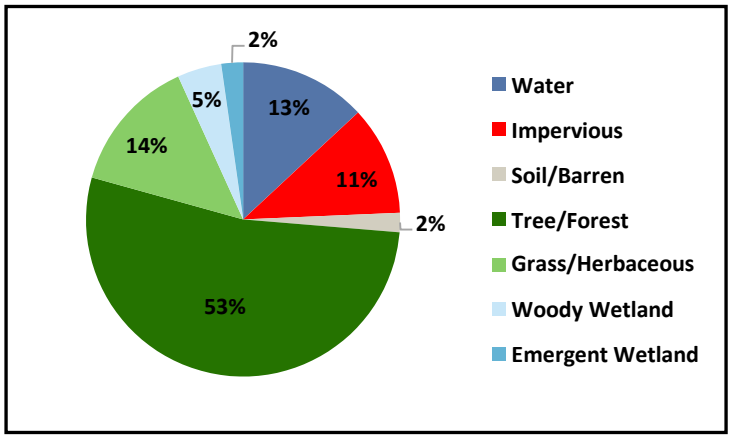

Figure 1: Areal percentage of MULC classes for New Haven, CT

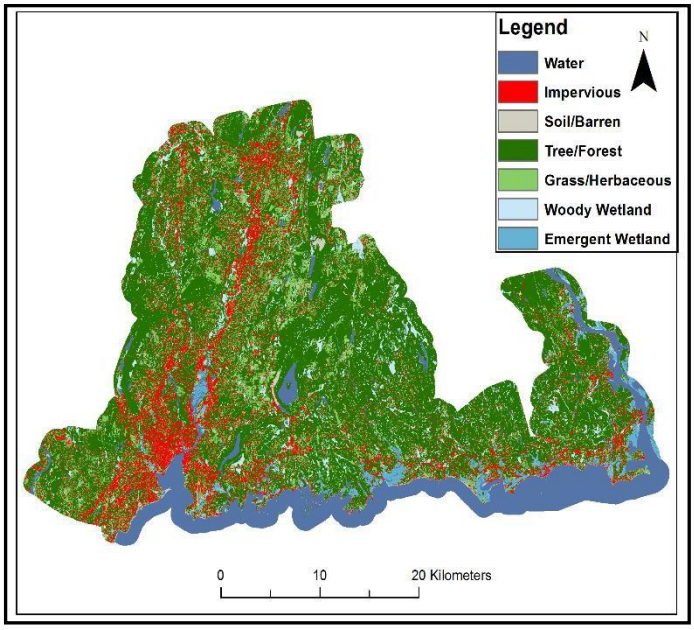

Figure 2: MULC for New Haven, CT.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorus, and total suspended solids (kg/yr) from filtration by trees

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How were the data for this map created?

The MULC data for New Haven, CT were generated from digital image processing and supervised classification of aerial photography, LiDAR, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer/fall 2014 and LiDAR collected in winter 2006 and 2010/2011.

A pixel-based classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map two additional classes: Woody Wetlands and Emergent Wetlands.[4]

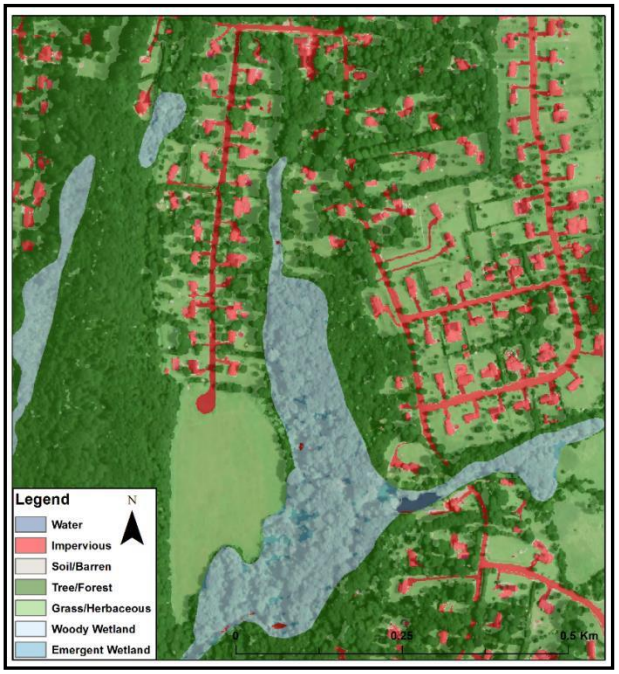

Figure 3: New Haven MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 600 photo-interpreted reference points yielded an overall User's Accuracy of about 89 percent for the New Haven MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the New Haven MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the New Haven, CT area was developed by Chelsea Fizer, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover New York City, NY

This EnviroAtlas map shows land cover for the New York City, NY area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. In comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

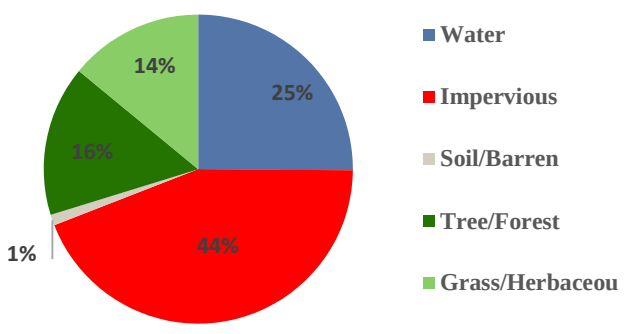

Figure 4: Areal percentage of MULC classes for New York, NY.

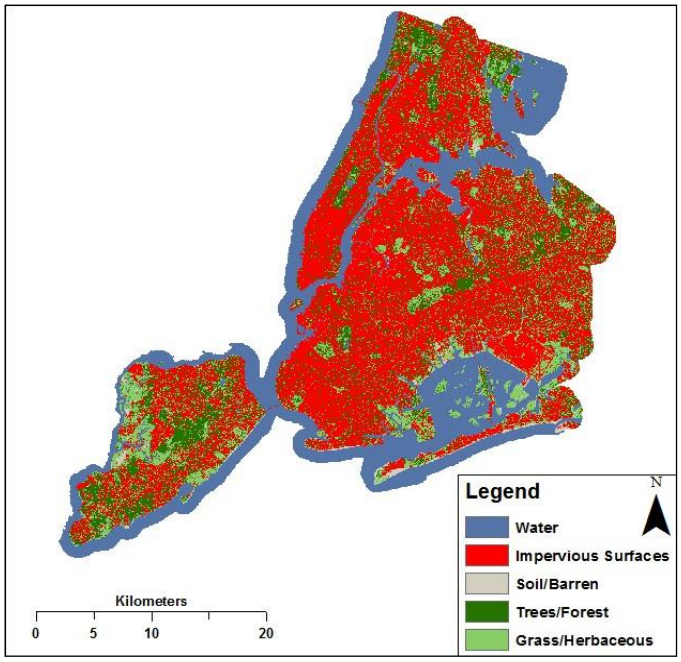

Figure 2: MULC for New York, NY.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorus, and total suspended solids (kg/yr) from filtration by trees

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How were the data for this map created?

The MULC data for New York City, NY were generated from digital image processing and object-based image analysis (OBIA) of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2011 and LiDAR collected in 2010.

A rule-based feature extraction software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water.

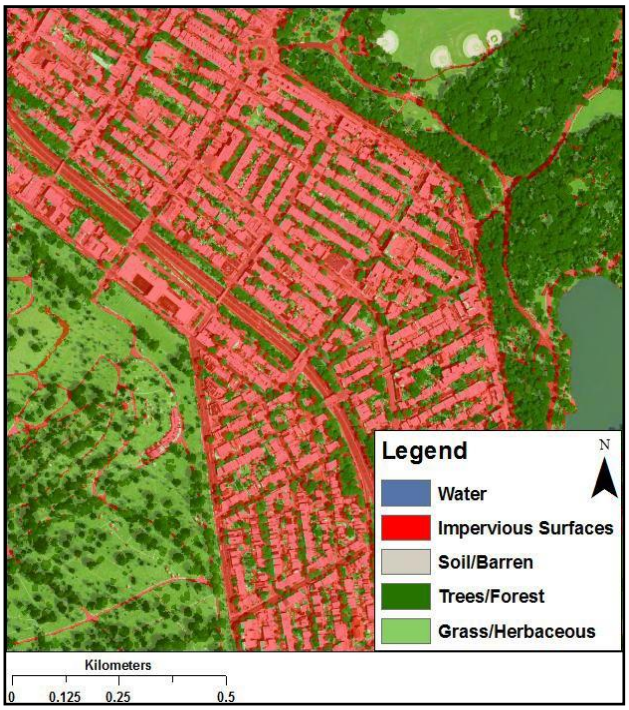

Figure 3: New York City MULC with 50% transparency displayed on top of aerial imagery. The spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 655 photo-interpreted reference points yielded an overall User's Accuracy of about 87 percent for the New York City MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Austin MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for New York City, NY was developed by the University of Vermont Spatial Analysis Laboratory (SAL) under the direction of Jarlath O'Neil-Dunne and adapted by Charles Rudder, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Paterson, New Jersey

This EnviroAtlas map shows land cover for the Paterson, NJ area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

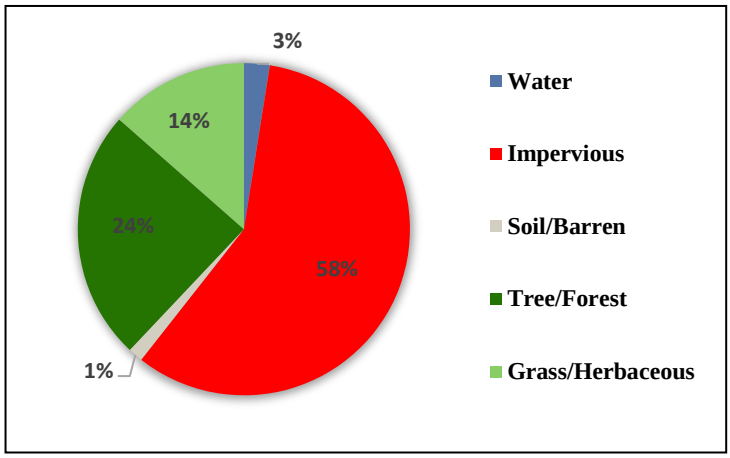

Figure 1: Areal percentage of MULC classes for Paterson, NJ.

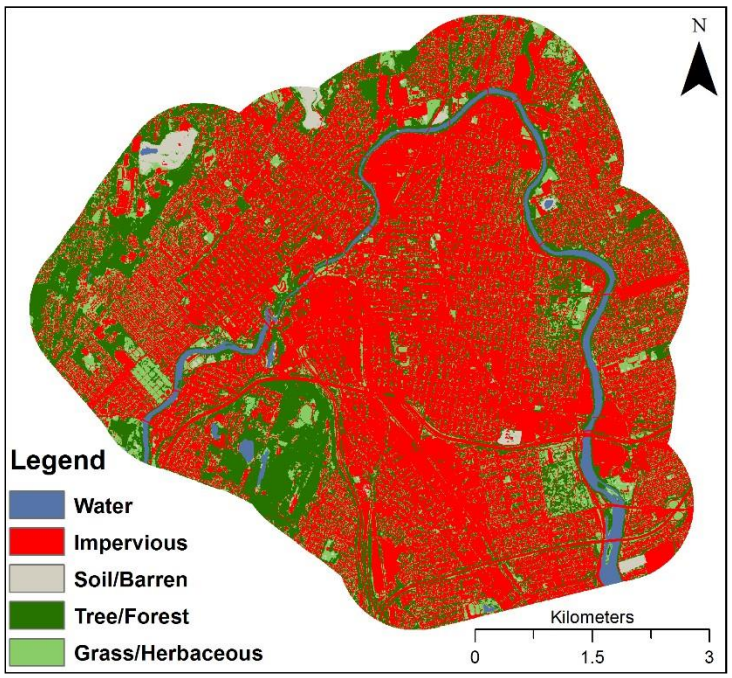

Figure 2: MULC for Paterson, NJ.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Paterson, NJ were generated from digital image processing and supervised classification of aerial photography. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2010.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water.

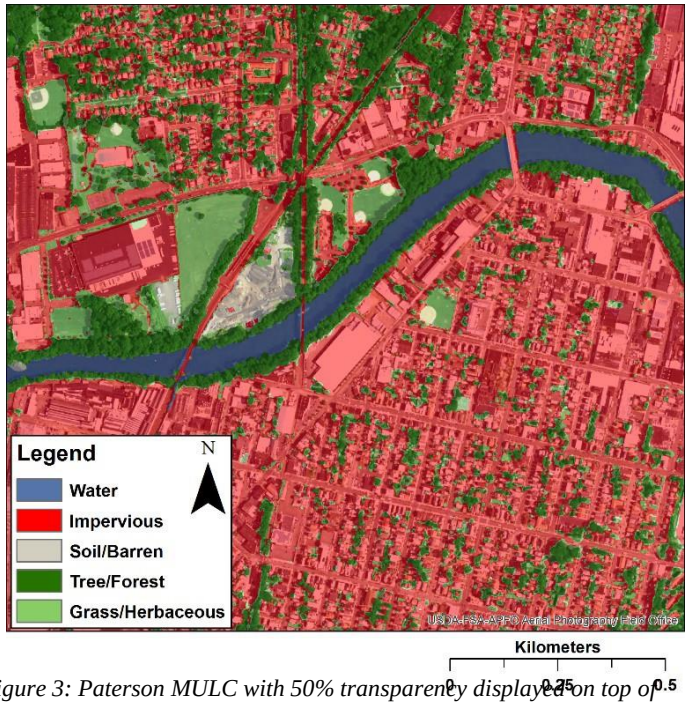

Figure 3: Paterson MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 564 photo-interpreted reference points yielded an overall User's Accuracy of about 87 percent for the Paterson MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Paterson MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Paterson, NJ area was developed by Jeremy Baynes, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Philadelphia, PA

This EnviroAtlas map shows land cover for the Philadephia, PA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Shrub, Grass and Herbaceous, Agriculture, Orchard, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for everyone NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

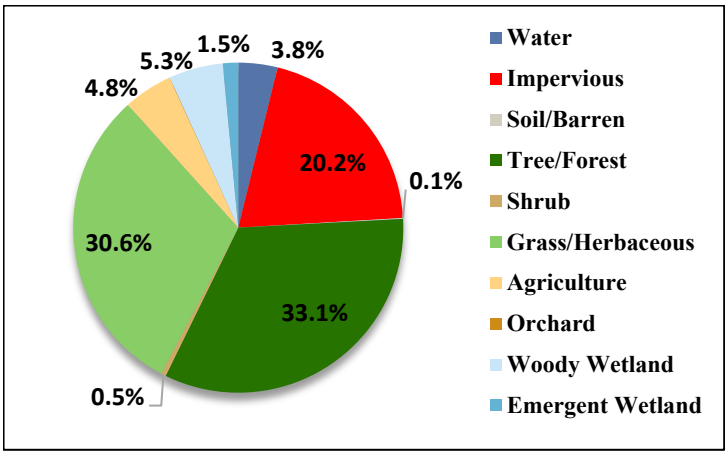

Figure 1: Areal percentage of MULC classes for Philadelphia, PA.

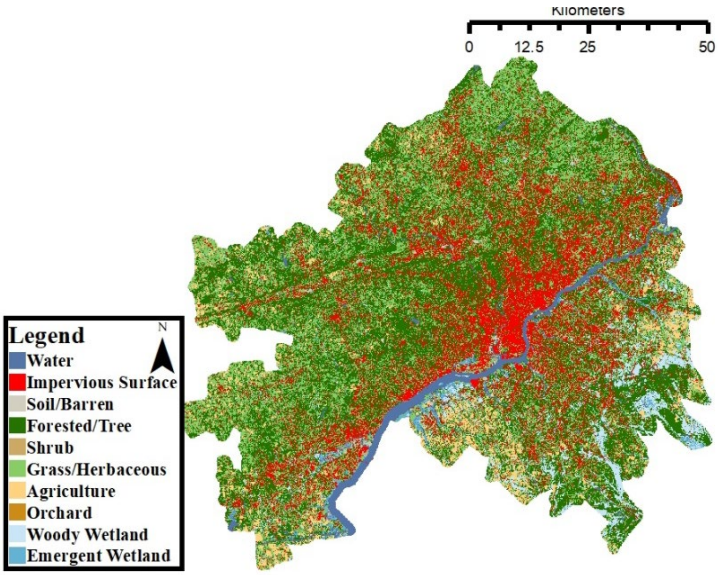

Figure 2: MULC for Philadelphia, PA

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Philadelphia, PA were generated from digital image processing and object-based image analysis (OBIA) of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from multiple sources including the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer/fall 2013, additional orthoimagery from 2005-2008 and 2012-2015, and 2006-2008 (PA), 2011-2015 (MD), 2014 (DE), and 2015 (NJ) leaf-off LiDAR.

A rule-based feature extraction software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map three additional classes: Wetlands (Woody and Emergent)[4], Agriculture, and Orchards. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

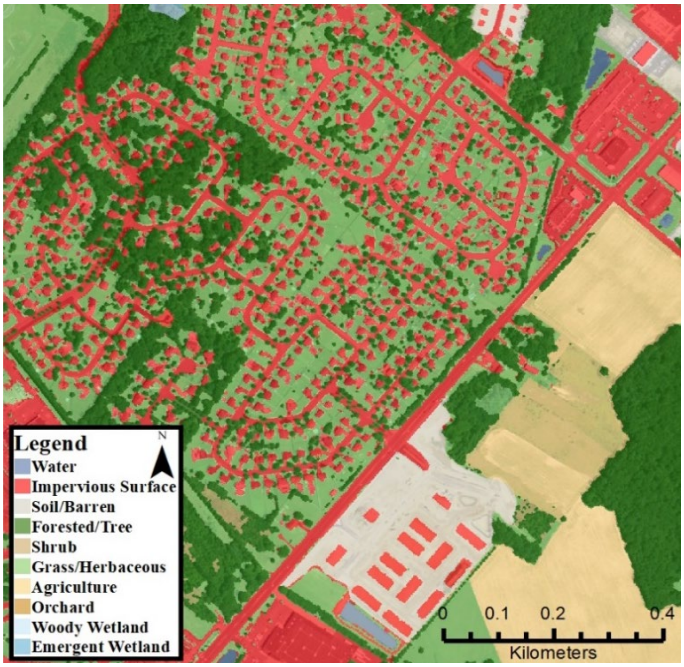

Figure 3: Philadelphia MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 851 photo-interpreted reference points yielded an overall User's Accuracy of about 77 percent for the Philadelphia MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Philadephia MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Development Team for further inquiries.

Acknowledgements

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Philadephia MULC was developed by the UVM Spatial Analysis Lab, Gillian Gundersen, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. A Land Use and LC Classification System for Use with Remote Sensor Data. Geological Survey Professional Paper 964, U. S. Dept. of Interior.

2. Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345-354.

3. U.S. Department of Agriculture, Farm Service Agency, 2010. Aerial Photography Field Office: U.S. Department of Agriculture Web page. https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/.

4. U.S. Fish and Wildlife Service. National Wetlands Inventory digital data. Website: http://wetlands.fws.gov/.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. Ecosystem Services, 14, 45-55.

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Meter Scale Urban Land Cover Phoenix, Arizona

This EnviroAtlas map shows land cover for the Phoenix, AZ area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, and Agriculture.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

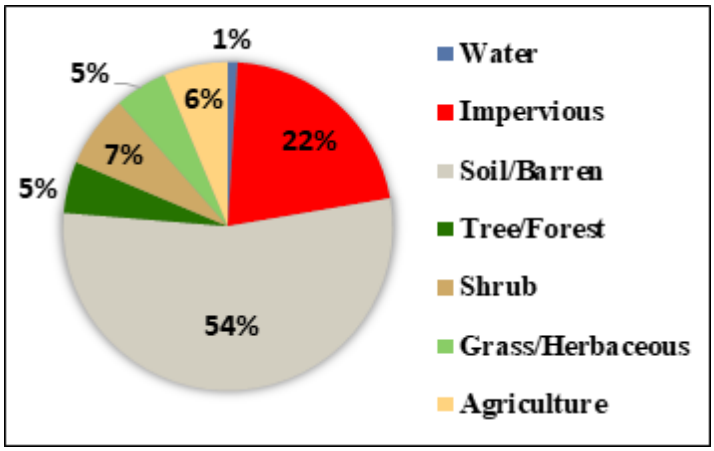

Figure 1: Areal percentage of MULC classes for Phoenix, AZ.

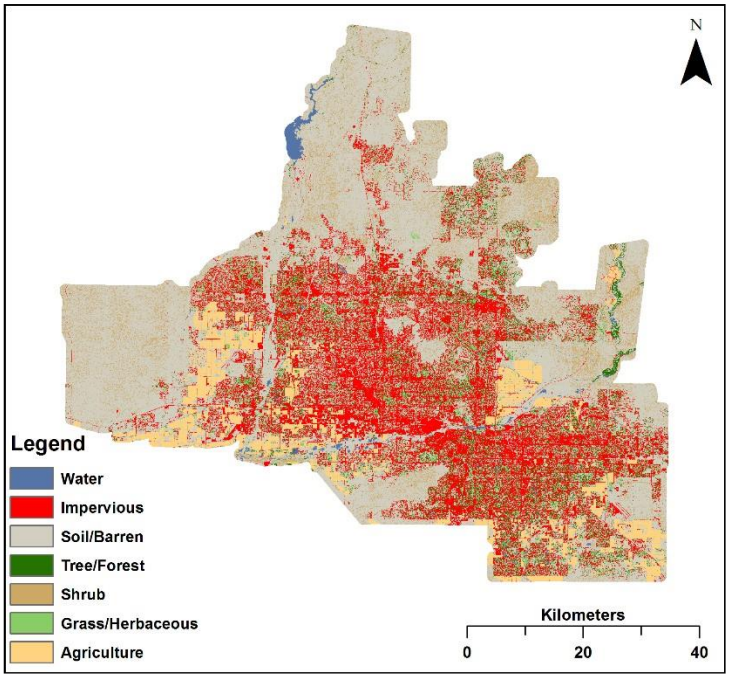

Figure 2: MULC for Phoenix, AZ.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Phoenix, AZ were generated from digital image processing and object-based image analysis (OBIA) of aerial photography and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer/fall 2010.

A rule-based feature extraction software was used to identify six common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, Water, and Agriculture.

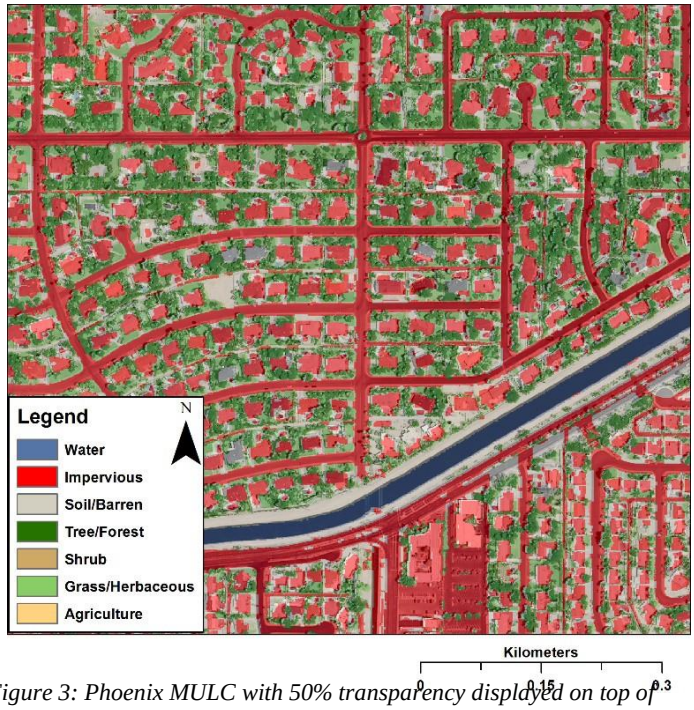

Figure 3: Phoenix MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 598 photo-interpreted reference points yielded an overall User's Accuracy of about 69.2 percent for the Phoenix MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Phoenix MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Phoenix, Arizona area was developed by Arizona State University ERSG Lab and supplemented by Matthew Dannenberg, EPA Student Services Contractor, Sam Pardo, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Pittsburgh, PA

This EnviroAtlas map shows land cover for the Pittsburgh, PA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

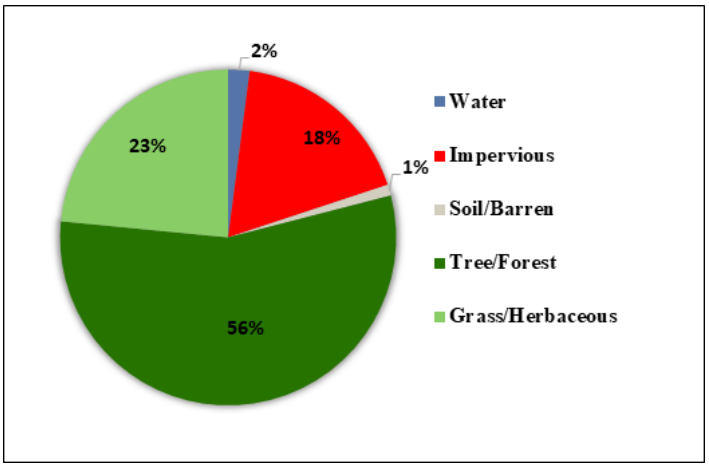

Figure 1: Areal percentage of MULC classes for Pittsburgh, PA.

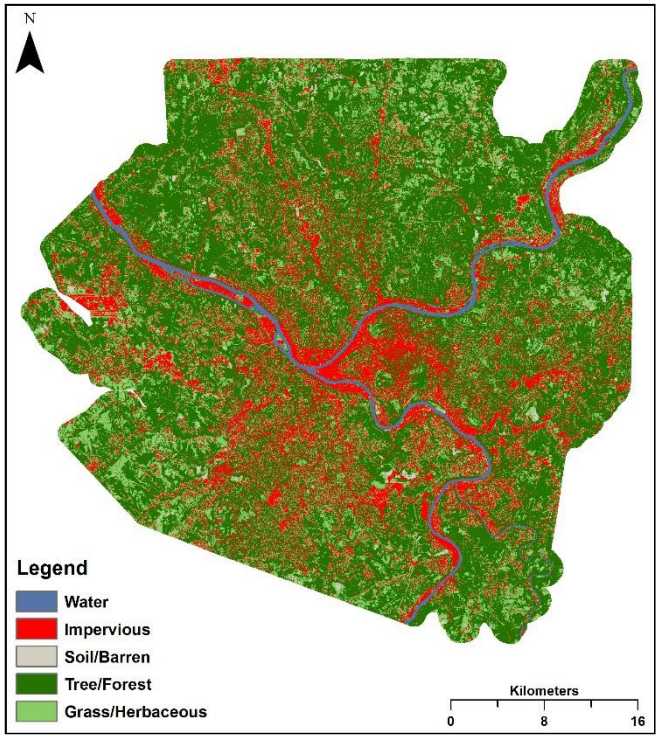

Figure 2: MULC for Pittsburgh, PA.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Pittsburgh, PA were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2010 and LiDAR collected in 2006.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water.

Figure 3: Pittsburgh MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 581 photo-interpreted reference points yielded an overall User's Accuracy of about 86 percent for the Pittsburgh MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Pittsburgh MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Pittsburgh, PA area was developed by Jeremy Baynes, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Portland, Maine

This EnviroAtlas map shows land cover for the Portland, ME area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

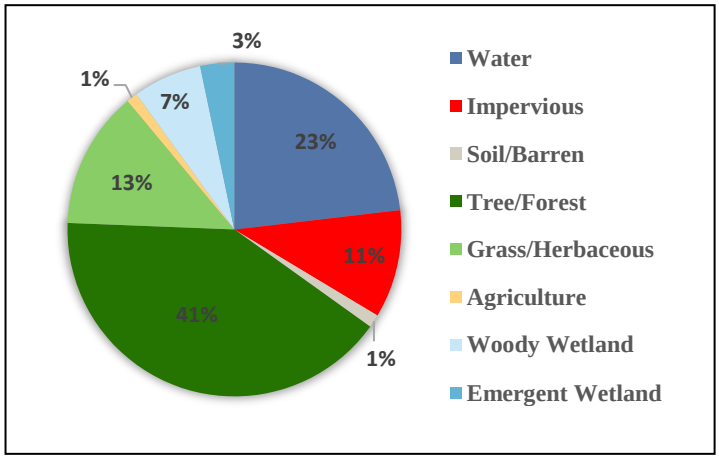

Figure 1: Areal percentage of MULC classes for Portland, ME.

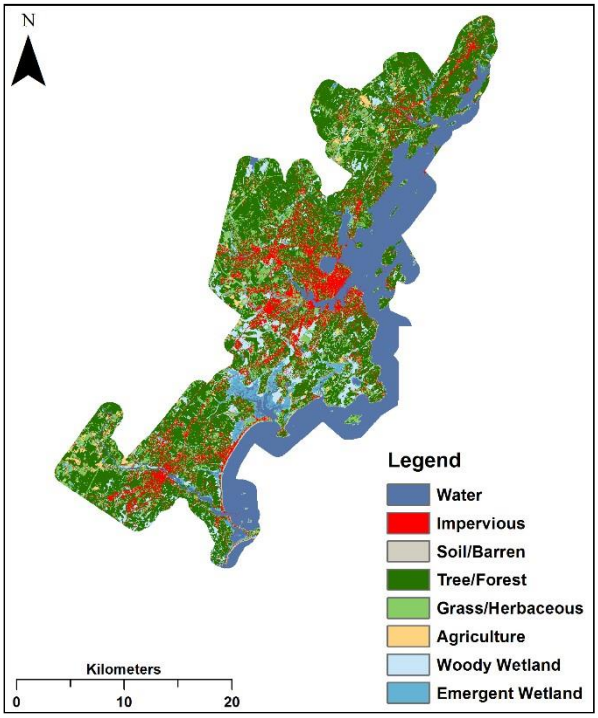

Figure 2: MULC for Portland, ME.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Portland, ME were generated from digital image processing and supervised classification of aerial photography and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2010.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map three additional classes: Wetlands (Woody and Emergent)[4] and Agriculture. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

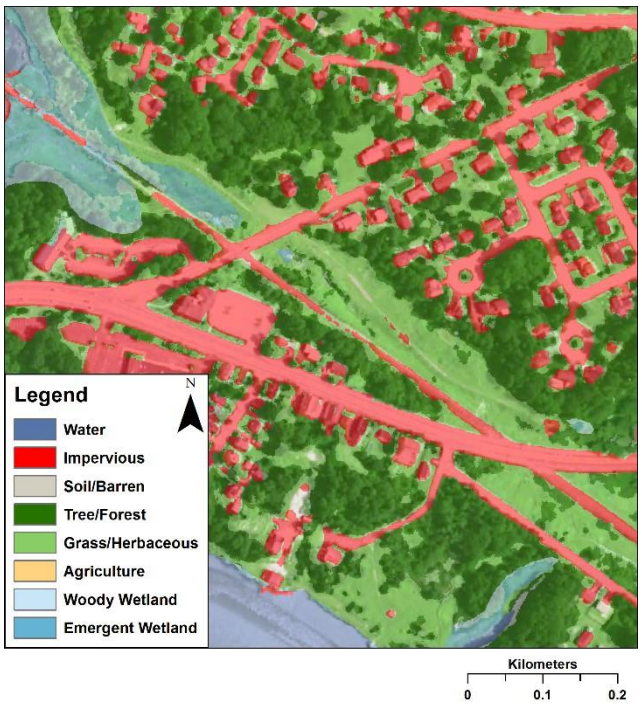

Figure 3: Portland, ME MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 600 photo-interpreted reference points yielded an overall User's Accuracy of about 87 percent for the Portland, ME MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Portland, ME MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Portland, ME area was developed by Jeremy Baynes, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Portland, Oregon

This EnviroAtlas map shows land cover for the Portland, OR area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

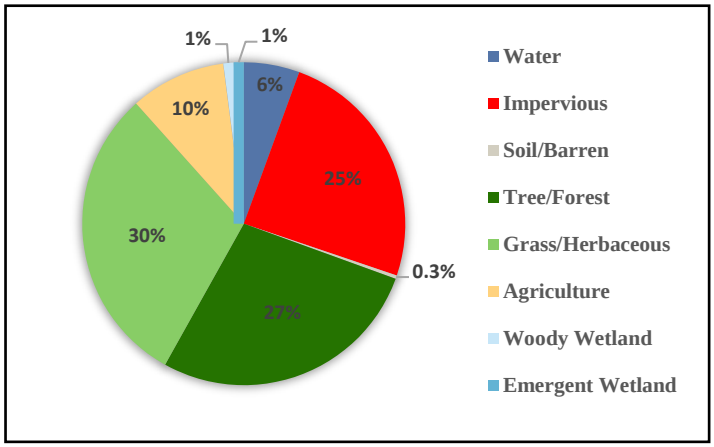

Figure 1: Areal percentage of MULC classes for Portland, OR.

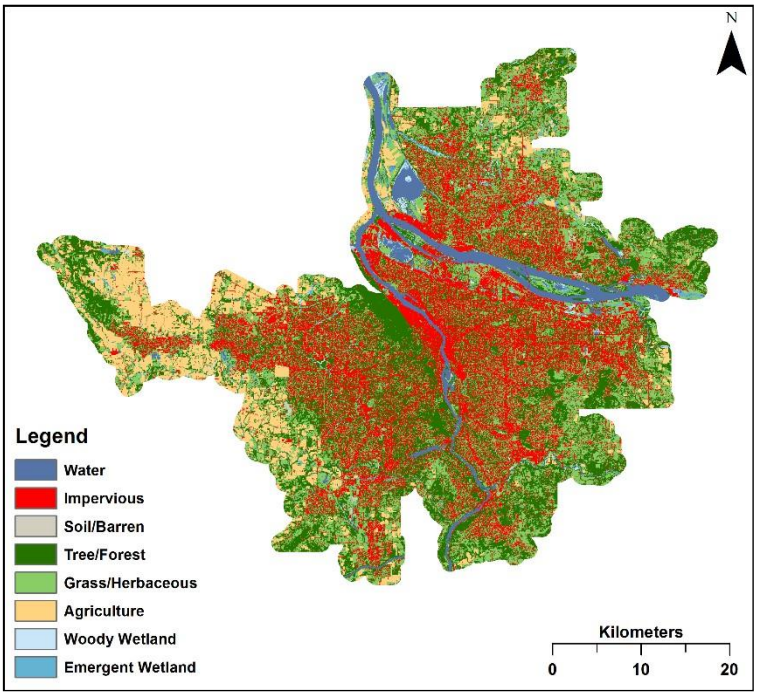

Figure 2: MULC for Portland, OR.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Portland, Oregon were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2011 and 2012. LiDAR was collected in 2007 and 2010.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map three additional classes: Wetlands (Woody and Emergent)[4] and Agriculture. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

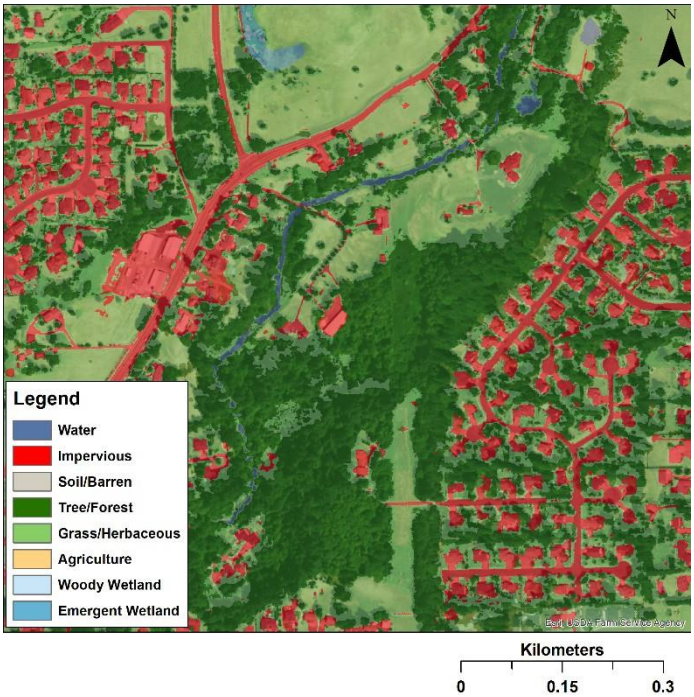

Figure 3: Portland, OR MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 654 photo-interpreted reference points yielded an overall User's Accuracy of about 79 percent for the Portland, OR MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Portland, OR MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Portland, OR area was developed by Ben Riegel, Jeremy Baynes, and Charles Rudder, EPA Student Services Contractors, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Salt Lake City, Utah

This EnviroAtlas map shows land cover for the Salt Lake City, UT area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Shrub, Grass and Herbaceous, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

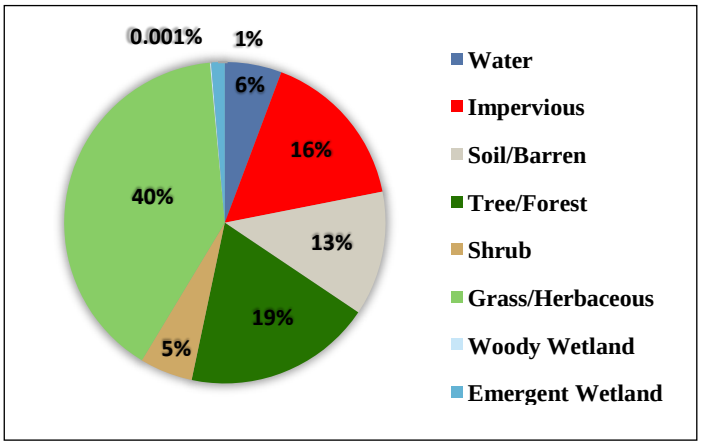

Figure 1: Areal percentage of MULC classes for Salt Lake City, UT.

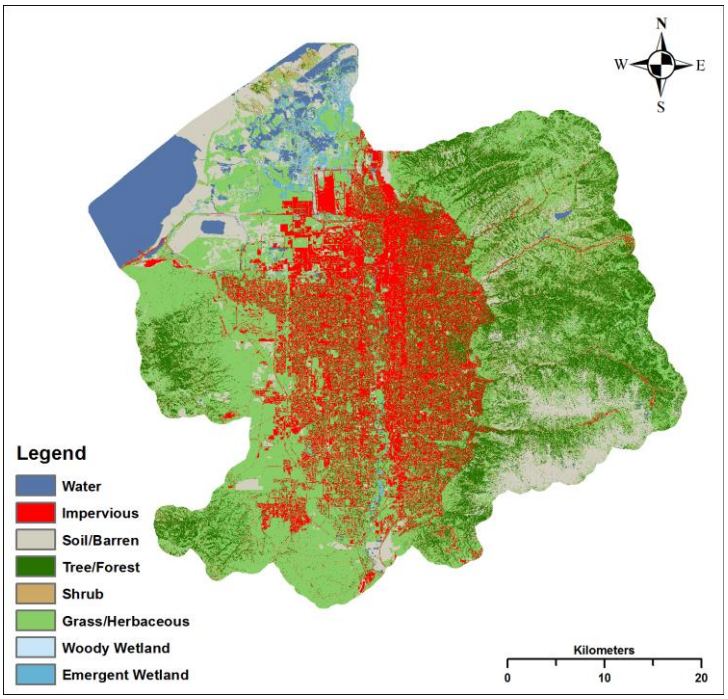

Figure 2: MULC for Salt Lake City, UT.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Salt Lake City, UT were generated from digital image processing and object-based image analysis (OBIA) of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2014 and LiDAR from 2006, 2011, and 2013.

A rule-based feature extraction software was used to identify six common land cover classes: Impervious Surface, Soil/Barren, Shrub, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map Wetlands (Woody and Emergent)[4]. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

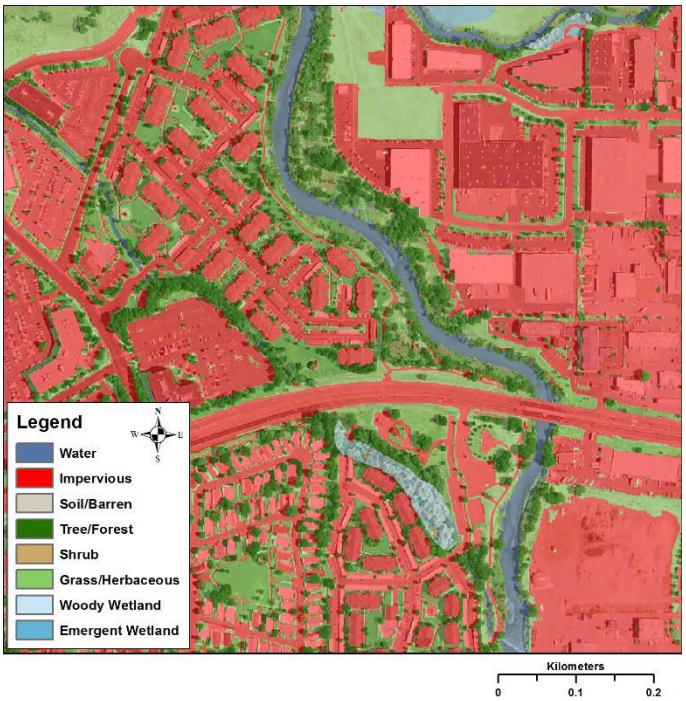

Figure 3: Salt Lake City, UT MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 647 photo-interpreted reference points yielded an overall User's Accuracy of about 79 percent for the Salt Lake City MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Salt Lake City MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Salt Lake City, UT area was developed by Daniel Rosenbaum, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Sonoma County, CA

This EnviroAtlas map shows land cover for the Sonoma County, CA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Shrub, Grass and Herbaceous, Agriculture, Orchard, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

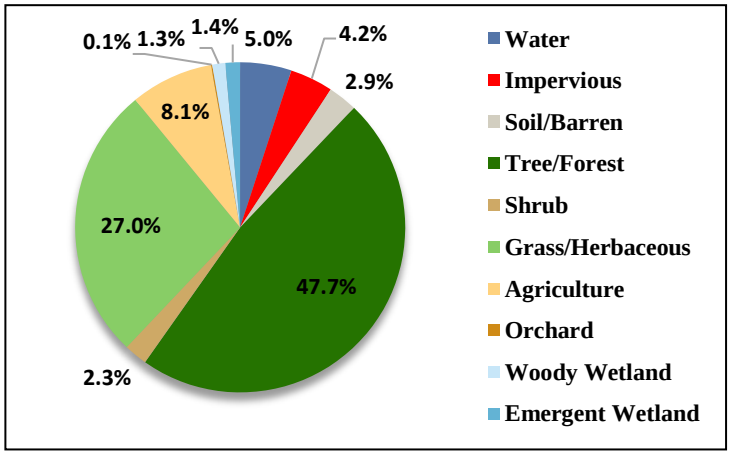

Figure 1: Areal percentage of MULC classes for Sonoma County, CA.

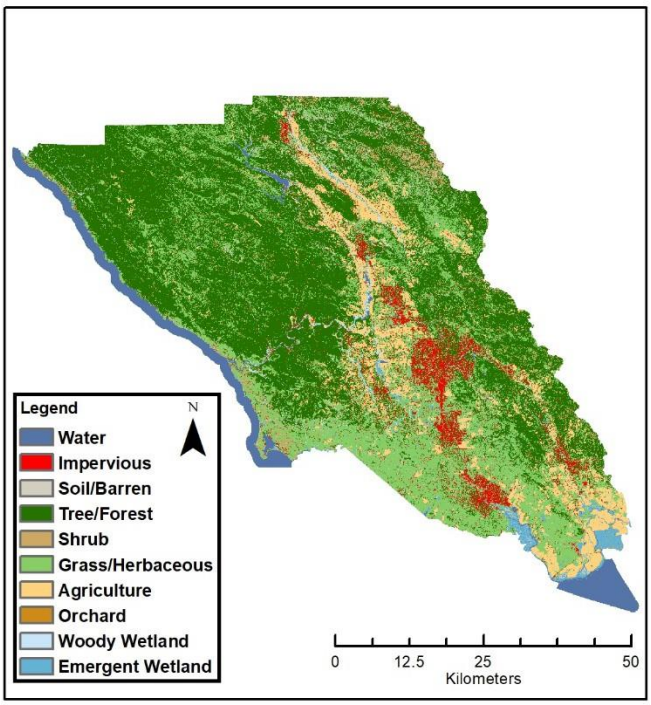

Figure 2: MULC for Sonoma County, CA.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Sonoma County, CA were generated from digital image processing and a hybrid method using object-based image analysis (OBIA) and threshold ruleset of aerial photography, LiDAR data, and the Sonoma County Vegetation Mapping & LiDAR Program datasets. The aerial photography is from the Sonoma County Vegetation Mapping & LiDAR Program and includes four spectral bands (blue, green, red, and near infrared) captured in 2011 and 2013.

A threshold-based ruleset in combination with the OBIA-derived classes produced by the Sonoma County Vegetation Mapping & LiDAR Program was used to identify ten common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, Shrub, Water, Agriculture, Orchard, and Wetlands (Woody and Emergent). Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

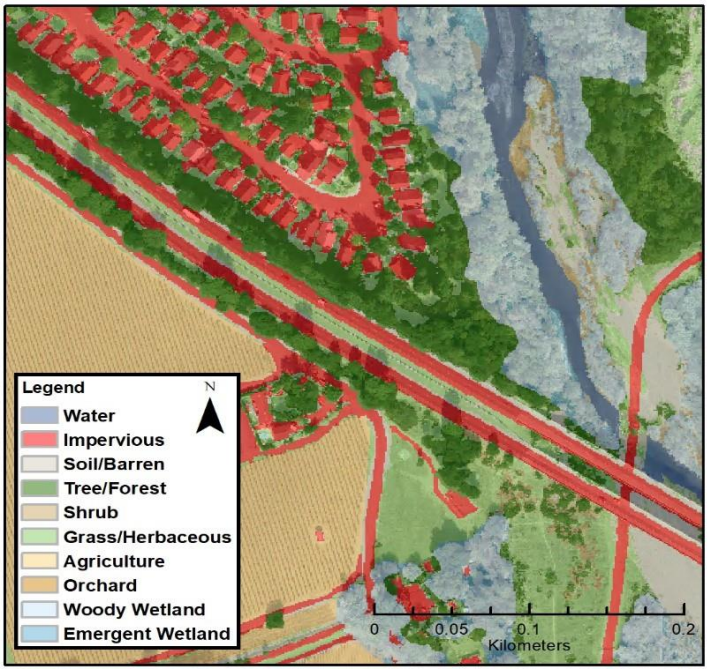

Figure 3: Sonoma County, CA with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 805 photo-interpreted reference points yielded an overall User's Accuracy of about 79 percent for the Sonoma County, CA. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Sonoma County MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Sonoma County, CA area was developed by the Sonoma County Vegetation Mapping and LiDAR Program, Jeremy Baynes, EPA, Gillian Gundersen, Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover St. Louis, MO

This EnviroAtlas map shows land cover for the St. Louis, MO area at high spatial resolution (1 meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

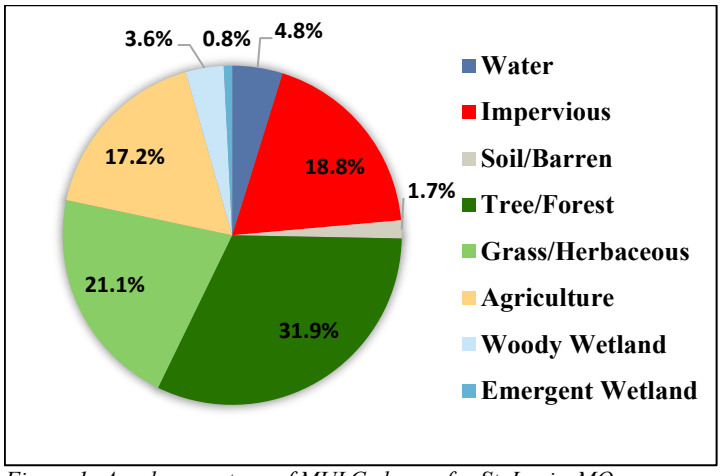

Figure 1: Areal percentage of MULC classes for St. Louis, MO.

How can I use this information?

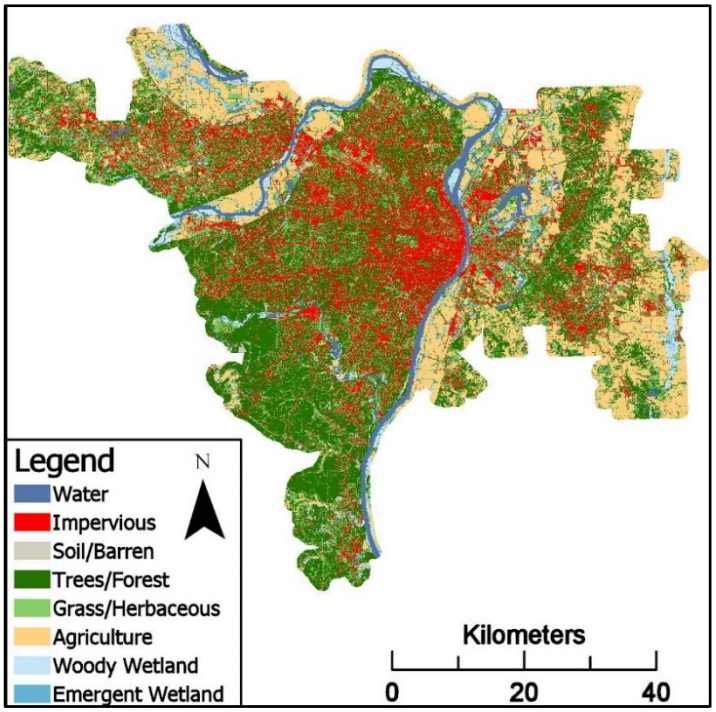

Figure 2: MULC for St. Louis, MO.

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for St. Louis, MO were generated from digital image processing, object-based image analysis (OBIA), and pixel based analysis of aerial photography, LiDAR data, and relevant ancillary datasets in three phases. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and other sources and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP and other imagery collected in summer/fall 2012, 2014, 2015, and 2016. LiDAR was collected between 2008 and 2012.

Two different rule-based feature extraction software and one pixel based supervised classification software were used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water.

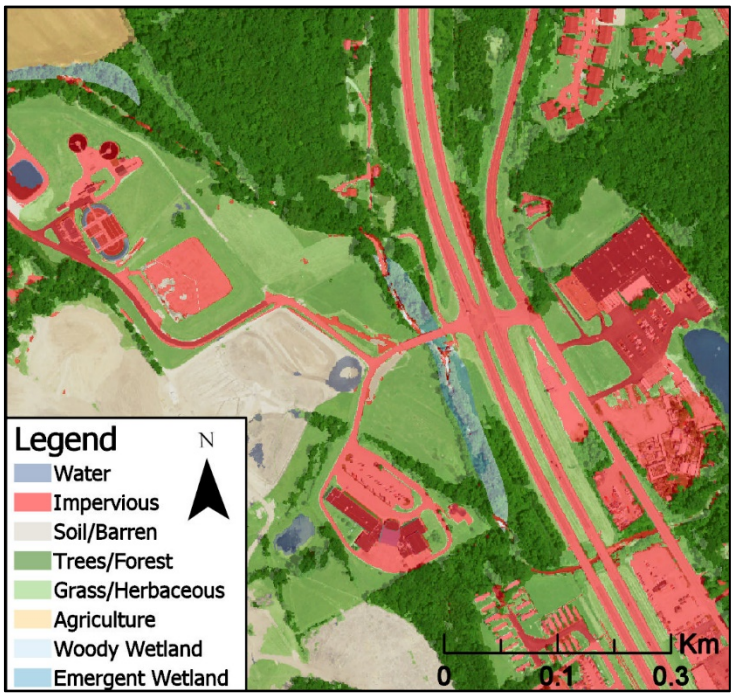

Figure 3: St. Louis MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Ancillary data were used to map three additional classes: Wetlands (Woody and Emergent)[4] and Agriculture. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 921 photo-interpreted reference points yielded an overall User's Accuracy of about 82 percent for the St. Louis MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the St. Louis MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Development Team for further inquiries.

Acknowledgements

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the St. Louis, MO area were developed by Missouri Resource Assessment Partnership under David Diamond, Akhilesh Khopkar and Gillian Gundersen, contractors to the EPA, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. A Land Use and LC Classification System for Use with Remote Sensor Data. Geological Survey Professional Paper 964, U. S. Dept. of Interior.
2. Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345-354.
3. U.S. Department of Agriculture, Farm Service Agency, 2016. Aerial Photography Field Office: U.S. Department of Agriculture Web page. https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/.
4. U.S. Fish and Wildlife Service. National Wetlands Inventory digital data. Website: http://wetlands.fws.gov/.
Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. Ecosystem Services, 14, 45-55.

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Meter Scale Urban Land Cover Tampa, Florida

This EnviroAtlas map shows land cover for the Tampa, Florida area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

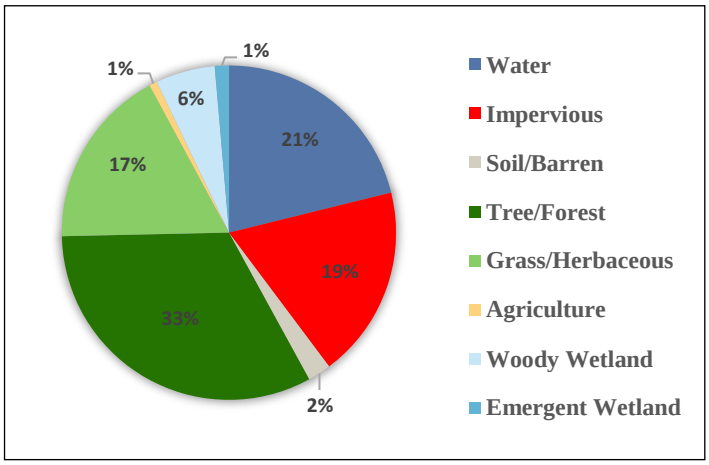

Figure 1: Areal percentage of MULC classes for Tampa, FL.

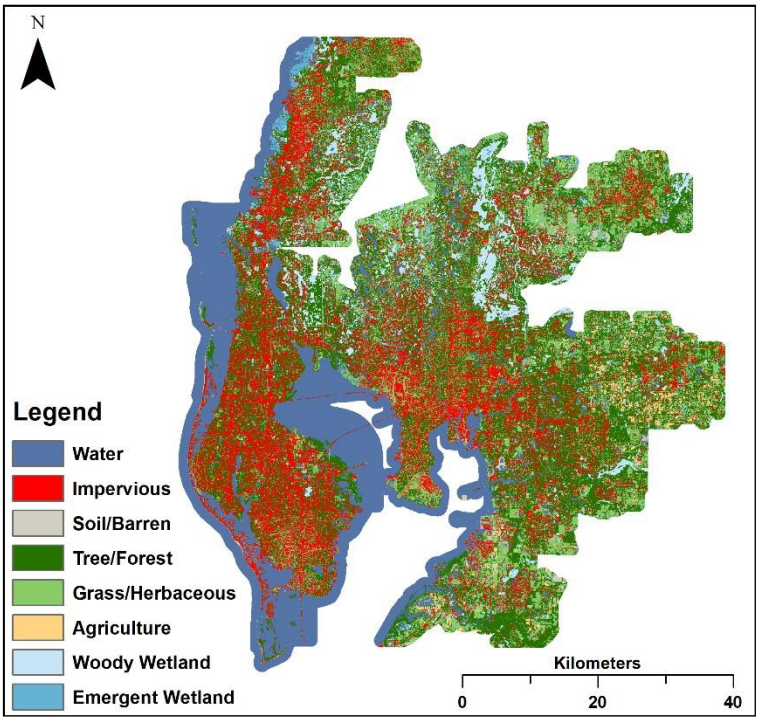

Figure 2: MULC for Tampa, FL.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Tampa, FL were generated from digital image processing and supervised classification of aerial photography and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in spring 2010.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map three additional classes: Wetlands (Woody and Emergent)[4] and Agriculture. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

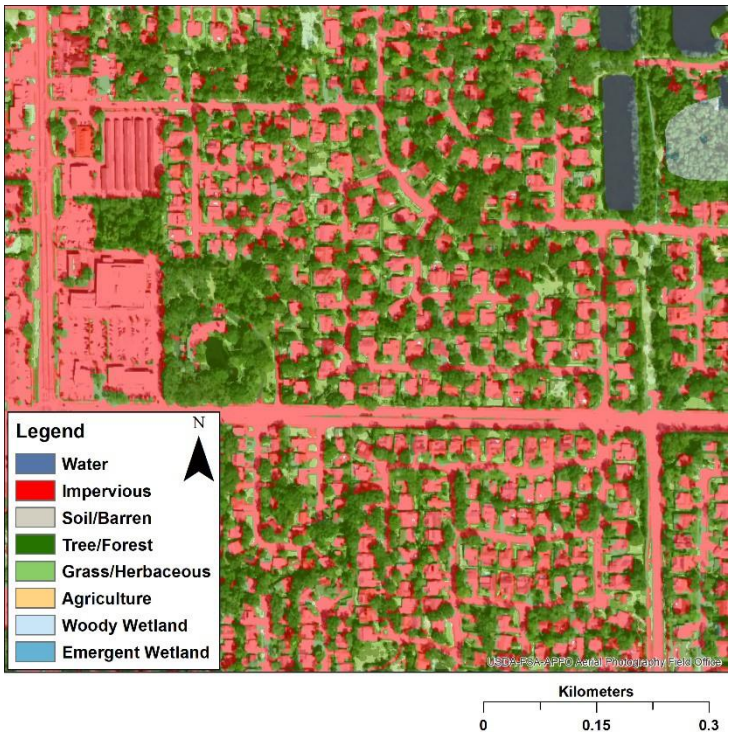

Figure 3: Tampa MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 597 photo-interpreted reference points yielded an overall User's Accuracy of about 71 percent for the Tampa MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Tampa, FL MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas meter scale land cover data for the Tampa, Florida area was developed by Matthew Dannenberg, EPA Student Services Contractor, and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

Meter Scale Urban Land Cover Virginia Beach, VA

This EnviroAtlas map shows land cover for the Virginia Beach, VA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland, and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30- meter pixel resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the assessment of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

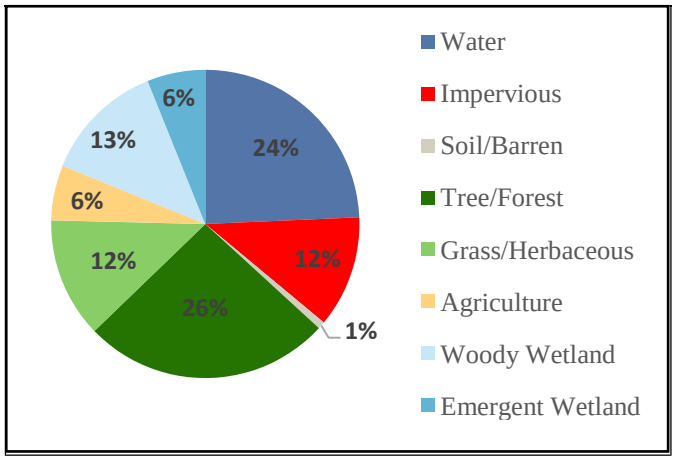

Figure 7: Areal percentage of MULC classes for Virginia Beach, VA

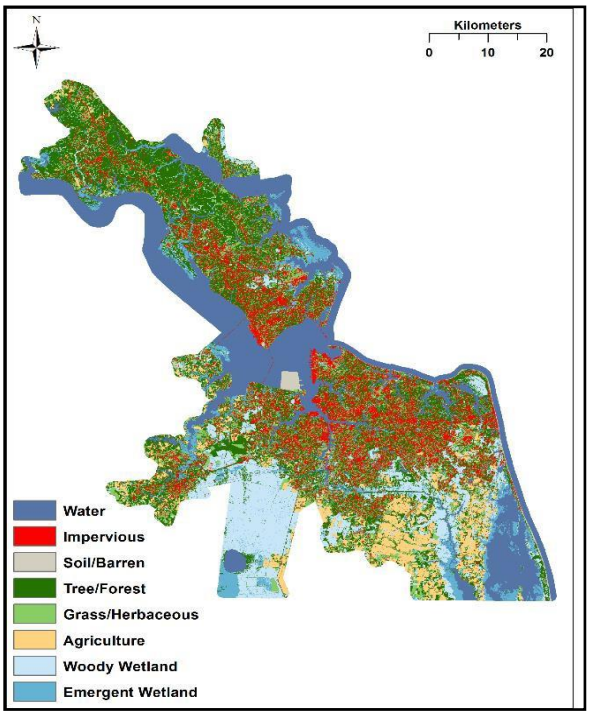

Figure 2: MULC for Virginia Beach, VA

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (metric tons)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorus, and total suspended solids (kg/yr) from filtration by trees.

CONTINUED ON BACK

How were the data for this map created?

The MULC data for Virginia Beach were generated from digital image processing and supervised feature extraction of aerial photography, LiDAR data (2010; 2013) and relevant ancillary datasets. The aerial photography is from the Virginia Base Mapping Program (VBMP, 2013 leaf off) and the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP, 2014 leaf on), [3] both of which include four spectral bands (blue, green, red, and near infrared).

A rule-based feature extraction software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map Wetlands (Woody and Emergent)[4] and Agriculture.

Figure 3: Virginia Beach, VA MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 712 photo-interpreted reference points yielded an overall User's Accuracy of about 84 percent for the Virginia Beach MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Austin MULC data were created. A selection of resources related to land cover is available below. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Virginia Beach, VA area was created by WorldView Solutions, Inc. for the Virginia Geographic Information Network, amended by the Chesapeake Conservancy, and further amended by EPA analysts.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018.

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.

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Meter Scale Urban Land Cover Washington DC

This EnviroAtlas map shows land cover for the Washington DC area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, Agriculture, Woody Wetland and Emergent Wetland.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

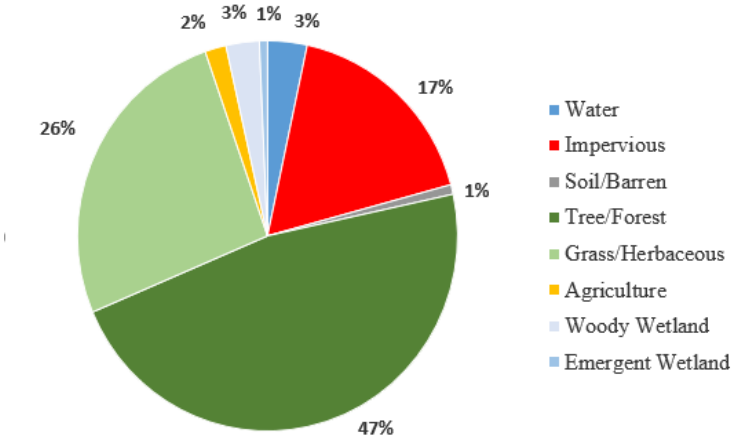

Figure 1: Areal percentage of MULC classes for Washington DC.

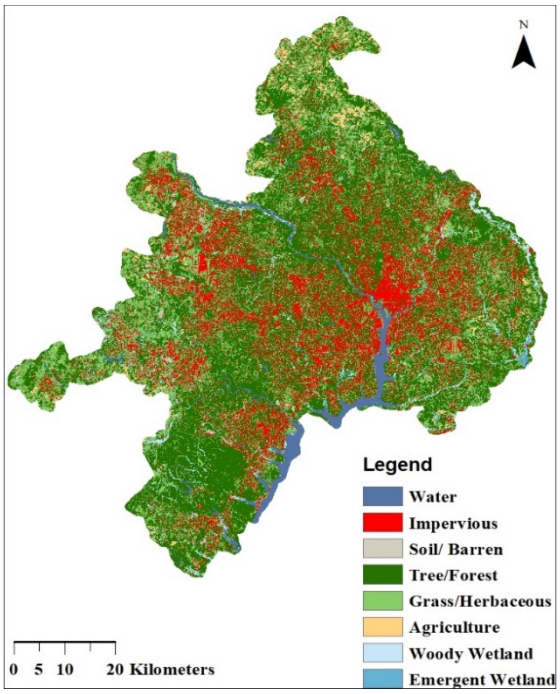

Figure 2: MULC for Washington, DC

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Washington D.C. were developed by the Chesapeake Bay Conservancy[3] and converted into EnviroAtlas MULC by the EPA. The data were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[4] and includes four spectral bands (blue, green, red and NIR). This MULC used NAIP imagery collected in 2014 for the Virginia area and summer/fall 2013 for the Maryland and DC sections. LiDAR was subject to availability and collected between 2002 and 2016.

A rule-based feature extraction software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree, and Water. Three additional classes: Wetlands (Woody and Emergent)[5] and Agriculture were added to the classified product. Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

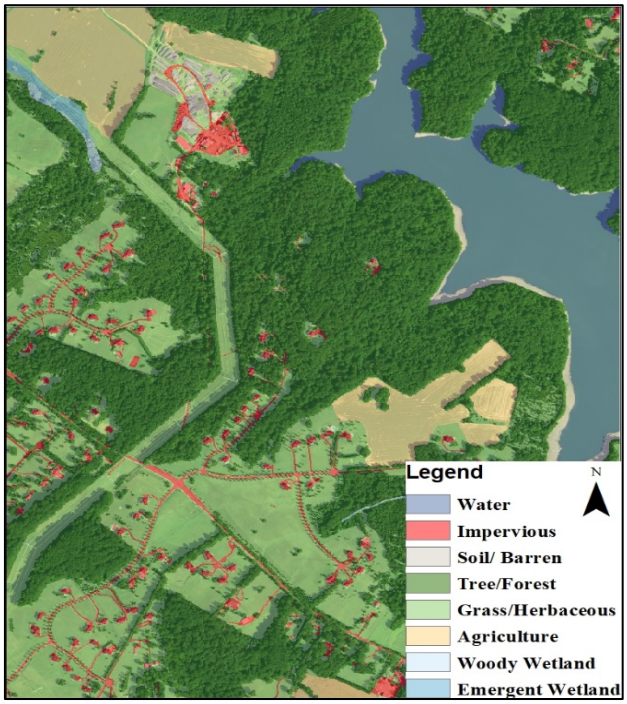

Figure 3: Washington DC MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

What are the limitations of these data?

A land cover map is a model of the landscape, and an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 711 photo-interpreted reference points yielded an overall User's accuracy of about 85 percent for the Washington DC MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Washington DC MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Development Team for further inquiries.

Acknowledgements

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Washington DC area were developed by Chesapeake Conservancy, Shanti Shrestha, ORAU Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J. R., E. E. Hardy, J. T. Roach, and R. E. Witmer. 1976. A Land Use and LC Classification System for Use with Remote Sensor Data. Geological Survey Professional Paper 964, U. S. Dept. of Interior.
2. Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345-354.
3. Chesapeake Conservancy, 2019. Land Cover Data Project. Website: http://chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-cover-data-project/.
4. U.S. Department of Agriculture, Farm Service Agency, 2010. Aerial Photography Field Office: U.S. Department of Agriculture Web page. https://www.fsa.usda.gov/programs-and-services/aerial-photography/imagery-programs/naip-imagery/.
5. U.S. Fish and Wildlife Service. National Wetlands Inventory digital data. Website: http://wetlands.fws.gov/.
Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. Ecosystem Services, 14, 45-55.

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Meter Scale Urban Land Cover Woodbine, IA

This EnviroAtlas map shows land cover for the Woodbine, IA area at high spatial resolution (1-meter pixels). The land cover classes are Water, Impervious Surface, Soil and Barren, Trees and Forest, Grass and Herbaceous, and Agriculture.[1]

Why is high resolution land cover important?

Land cover data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. The National Land Cover Dataset (NLCD)[2] provides land cover for the entire contiguous U.S. at 30-meter resolution. However, for some analyses, the density and heterogeneity of an urban landscape requires higher resolution land cover data. Meter Scale Urban Land Cover (MULC) data were developed to fulfill that need. By comparison, there are 900 MULC pixels for every one NLCD pixel.

Anticipated users of MULC include city and regional planners, water authorities, wildlife and natural resource managers, public health officials, citizens, teachers, and students. Potential applications of these data include the design of wildlife corridors and riparian buffers, stormwater management, urban heat island mitigation, access to recreation and green space, urban forestry, and urban landscape ecology.

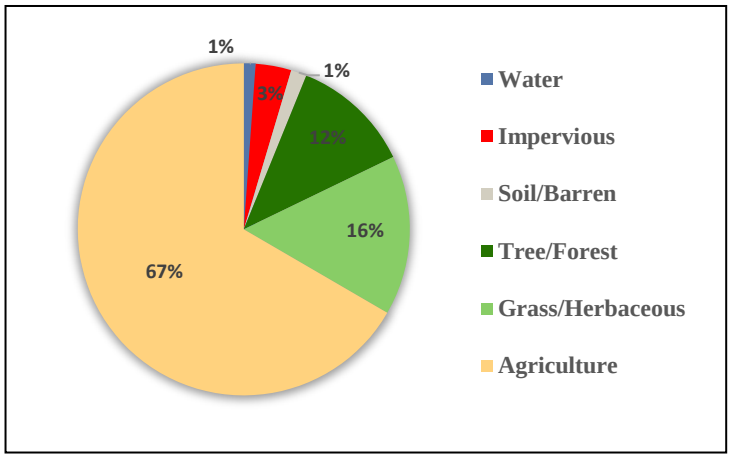

Figure 1: Areal percentage of MULC classes for Woodbine, IA.

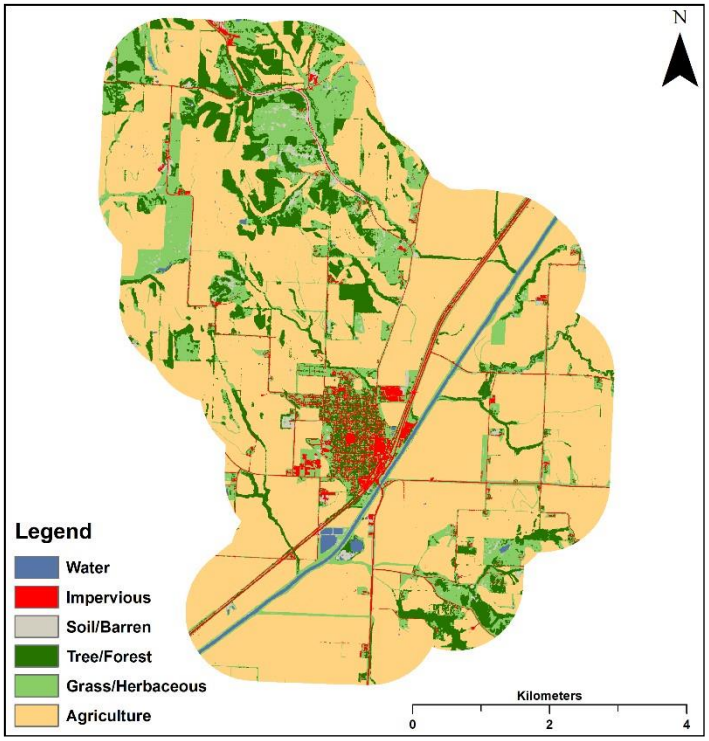

Figure 2: MULC for Woodbine, IA.

How can I use this information?

This data layer can be used alone or combined visually and analytically with other spatial data layers. MULC and its derivatives support numerous lines of investigation into human and ecosystem health in the urban landscape, such as: Where are the green and gray spaces? Which streets can benefit from more trees? What areas are subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers?

More than 85 EnviroAtlas data layers incorporate MULC in their computation, including:

- Total carbon stored in above ground tree biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Estimated percent of tree cover within 26 m of a busy road edge
- Reduction in median load of nitrites and nitrates, soluble phosphorous, total suspended solids, etc. (kg/yr).

How were the data for this map created?

The MULC data for Woodbine, IA were generated from digital image processing and supervised classification of aerial photography, LiDAR data, and relevant ancillary datasets. The aerial photography is from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP)[3] and includes four spectral bands (blue, green, red, and near infrared). This MULC used NAIP imagery collected in summer 2011 and LiDAR from 2009.

A supervised classification software was used to identify five common land cover classes: Impervious Surface, Soil/Barren, Grass/Herbaceous, Tree/Forest, and Water. Ancillary data were primarily used to map Agriculture.

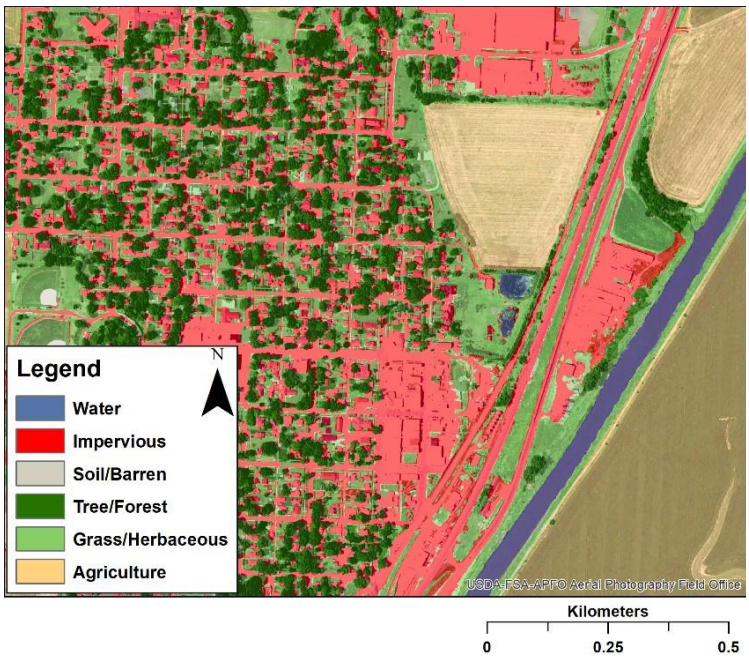

Figure 3: Woodbine MULC with 50% transparency displayed on top of aerial imagery. The fine spatial detail shows individual buildings, trees, and roads.

Manual editing was used to reduce confusion between classes, as needed. Data were organized and manipulated in a GIS. A description of the classification techniques and workflow is given in the metadata.

What are the limitations of these data?

A land cover map is a model of the landscape, and by definition an imperfect representation of reality. However, these maps are the best estimation of the truth based on the best available data. A formal accuracy assessment of 600 photo-interpreted reference points yielded an overall User's Accuracy of about 87 percent for the Woodbine MULC. Full accuracy results are reported in the metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata. Most errors are not evident when viewing at map scales smaller than approximately 1:8000.

How can I access these data?

EnviroAtlas data can be accessed by: (1) viewing them in the interactive map, (2) using the web services, or (3) downloading the data directly.

Where can I get more information?

Please refer to the metadata for a detailed description of how the Woodbine MULC data were created. The EnviroAtlas data download page links to MULC metadata. A selection of resources related to land cover is available below. Please contact the EnviroAtlas Team for further inquiries.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas MULC data for the Woodbine, IA area was developed by Charles Rudder, EPA Student Services Contractor and Drew Pilant, EPA.

Selected Publications

1. Anderson, J.R., E.E. Hardy, J.T. Roach, and R.E. Witmer. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U. S. Geological Survey, Washington, D.C.

2. Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing* 81(5): 345–354.

3. U.S. Department of Agriculture, Farm Service Agency. 2013. Aerial Photography Field Office, NAIP Imagery. Accessed March 2018

4. U.S. Fish and Wildlife Service. 2016. National Wetlands Inventory. Accessed March 2018.

Pickard, B. R., Daniel, J., Mehaffey, M., Jackson, L. E., & Neale, A. 2015. EnviroAtlas: A new geospatial tool to foster ecosystem services science and resource management. *Ecosystem Services* 14: 45–55.