- Austin, TX Landcover (coming soon)
- Cleveland, OH Landcover (coming soon)
- Des Moines, IA Landcover (coming soon)
- **Durham, NC Landcover**
- **Fresno, CA Landcover**
- **Green Bay, WI Landcover**
- Memphis, TN Landcover (coming soon)
- **Milwaukee, WI Landcover**
- Minneapolis/St. Paul, MN Landcover (coming soon)
- **New Bedford, MA Landcover**
- New York, NY Landcover (coming soon)
- **Paterson, NJ Landcover**
- **Phoenix, AZ Landcover**
- **Pittsburgh, PA Landcover**
- **Portland, ME Landcover**
- **Portland, OR Landcover**
- **Tampa, FL Landcover**
- **Woodbine, IA Landcover**

Durham, North Carolina Land Cover

EnviroAtlas maps for community land cover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale, represented by 30-meter resolution landcover data, and a higher resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution (1 meter scale) urban land cover (ULC) map that quantifies the type and areal extent of the material at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in NLCD, but there are approximately 900 ULC pixels inside the footprint of one 30x30 meter NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary for sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers, and students. Some potential applications of this map include stormwater and urban heat island mitigation;[1] habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover near busy roadways
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr) from filtration by trees

Urban land cover data show land cover patterns that control or influence human and ecosystem health in the urban landscape and support numerous lines of investigation. Metric information derived from this landcover data is summarized by census block groups. Levels of ecosystem services may be compared among different neighborhoods using the census block group reporting framework. Which

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streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.[2]

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparency land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation, and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP). NAIP characteristics include three visible and one near-infrared spectral bands, 1-meter spatial resolution, nation-wide availability on a three year update cycle, and low to no cost. Machine-learning, automated feature extraction software was used in supervised classification to identify five common land cover classes: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, and Water. Hand editing was used as needed. Data were organized and manipulated in a GIS.

The method for deriving high resolution landcover data is similar for each community; but there are differences in the number and type of landcover classes depending on the community's location, character, and landuse activities. For example, agricultural areas may be added for some communities, if present, and ancillary data such as National Wetlands Inventory (NWI) data may be used to assist in identifying wetlands.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Durham, North Carolina land cover data has an overall accuracy of about 83 percent. Full accuracy results are reported in the map metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

A selection of resources related to landcover and community analyses is listed below. In-depth information on the relationships between urban ecosystems and human residents, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas meter scale land cover data for the Durham, North Carolina area was developed by Drew Pilant, EPA, and Jeremy Baynes and Matthew Dannenberg, EPA Student Services Contractors. Drew Pilant wrote the fact sheet.

Selected Publications

1. Rosenzweig, C., W. Solecki, L. Parshall, S. Gaffin, B. Lynn, R. Goldberg, J. Cox, and S. Hodges. 2006. Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces. National Aeronautics and Space Administration, Washington, D.C.

2. Baker, J.P., D.W. Hulse, S.V. Gregory, D. White, J. Van Sickle, P.A. Berger, D. Dole, and N.H. Schumaker. 2004. Alternative futures for the Willamette River Basin, Oregon. *Ecological Applications* 14(2): 313–324.

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.

Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21.

Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Fresno, California Land Cover

EnviroAtlas maps for community land cover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. This layer is a high spatial resolution urban land cover (ULC) map that quantifies the type and areal extent of the material composition at earth's surface, such as trees, grass, impervious surfaces, water, and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, representing the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to National Land Cover Data (NLCD),[1,2] but at a higher spatial resolution: there are approximately 900 ULC pixels inside the footprint of one 30x30 m NLCD pixel.

Land cover is the foundation of the terrestrial biosphere, the zone of life on land. Land cover is the ecosystem matrix of surface materials in which cities are embedded. Land cover data are necessary for sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers and students. Some potential applications of this map include: stormwater and urban heat island mitigation; habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology. Land cover data at this high spatial resolution (1 m pixel) are rare. Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

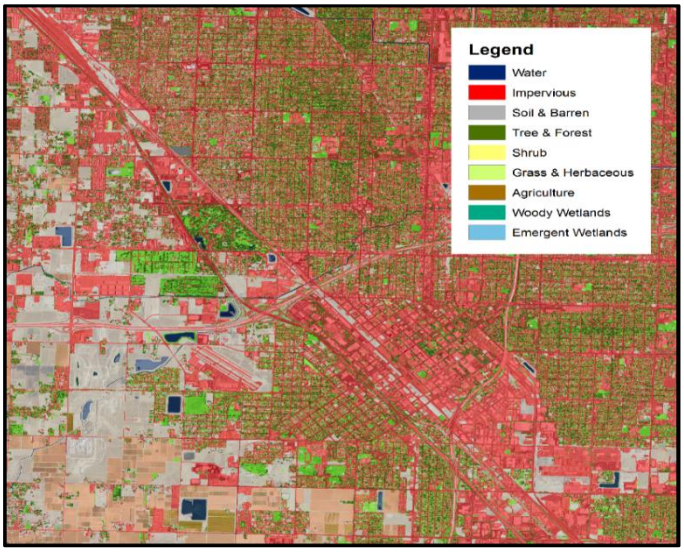

Figure 1 Fresno, CA urban land cover overlaid on air photo. Each color represents a specific LC class. Note the fine spatial detail showing individual buildings, trees, and roads.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other GIS layers. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover near busy roadways
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr)

This layer shows land cover patterns that control or influence human and ecosystem health in the urban landscape, and supports numerous lines of investigation. Which streets need more trees? What areas are mostly impervious surface and subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.[2]

Use the transparency slider (in the dropdown list from the **i**-button to the right of the map layer name) to explore how

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land cover relates to imagery and other EnviroAtlas layers. Experiment with multiple layer blending using variable-transparency land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP).[3] NAIP characteristics include three visible and one near infrared spectral bands, one meter pixel size, nation-wide availability on a three year update cycle, and low to no cost.

Machine learning, automated feature extraction software was used in supervised classification to identify five common land cover classes: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, and Water. Additional classification techniques including object based image analysis and heads up digitizing were used to identify an additional two classes: Agriculture and Orchards. Ancillary data included post-processed LiDAR derived elevation, reflective surfaces, and intensity values (SAIC LiDAR, 2012). Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Fresno, CA land cover has an overall fuzzy User's Accuracy of about 81 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

There are many resources available in the literature and on the internet to learn more about the societal benefits associated with land cover. A small subset of these resources has been listed in the selected publications section below.

In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. Jeremy Baynes, EPA Student Services Contractor developed the EnviroAtlas 1-meter scale land cover data for the Fresno, CA area. Drew Pilant and Jeremy Baynes created the fact sheet.

Selected Publications

1. U.S. Geological Survey. 2013. National Land Cover Database (NLCD). Accessed March 2015.

2. 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.

3. Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21.

Green Bay, Wisconsin Land Cover

EnviroAtlas maps for community land cover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. This layer is a high spatial resolution urban land cover (ULC) map that quantifies the type and areal extent of the material composition at earth's surface, such as trees, grass, impervious surfaces, water, and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, representing the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to National Land Cover Data (NLCD),[1,2] but at a higher spatial resolution: there are approximately 900 ULC pixels inside the footprint of one 30x30 m NLCD pixel.

Land cover is the foundation of the terrestrial biosphere, the zone of life on land. Land cover is the ecosystem matrix of surface materials in which cities are embedded. Land cover data are necessary for sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers and students. Some potential applications of this map include: stormwater and urban heat island mitigation; habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology. Land cover data at this high spatial resolution (1 m pixel) are rare. Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

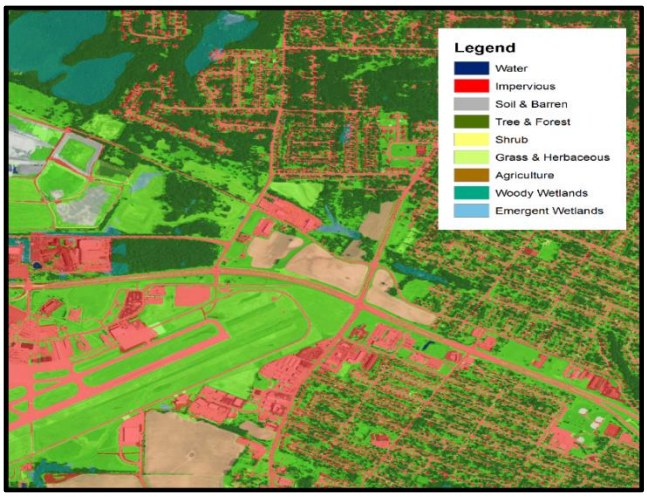

Figure 1 Green Bay, WI urban land cover overlaid on air photo. Each color represents a specific LC class. Note the fine spatial detail showing individual buildings, trees, and roads.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other GIS layers. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover near busy roadways
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr)

This layer shows land cover patterns that control or influence human and ecosystem health in the urban landscape, and supports numerous lines of investigation. Which streets need more trees? What areas are mostly impervious surface and subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.

Use the transparency slider (in the dropdown list from the **i**-button to the right of the map layer name) to explore how land cover relates to imagery and other EnviroAtlas layers.

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Experiment with multiple layer blending using variable-transparency land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP).[3] NAIP characteristics include three visible and one near infrared spectral bands, one meter pixel size, nation-wide availability on a three year update cycle, and low to no cost.

Machine learning, automated feature extraction software was used in supervised classification to identify five common land cover classes: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, and Water. Ancillary data were used to map two additional land cover classes: Wetlands (Woody and Emergent) and some water bodies.[4] Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Green Bay, Wisconsin land cover has an overall User's Accuracy of about 81 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

There are many resources available in the literature and on the internet to learn more about the societal benefits associated with land cover. A small subset of these resources has been listed in the selected publications section below.

In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas meter scale land cover data for the Green Bay area was developed by Ben Riegel, EPA Student Services Contractor and Drew Pilant, EPA. Drew Pilant and Ben Riegel wrote this fact sheet.

Selected Publications

1. U.S. Geological Survey. 2013. National Land Cover Database (NLCD). Accessed March 2015.

2. 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.

3. U.S.D.A. Farm Service Agency. National Agriculture Imagery Program (NAIP). Accessed June 2016,

4. U.S. Fish and Wildlife Service. National Wetlands Inventory data. Accessed June 2016.

Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21.

Milwaukee, Wisconsin Land Cover

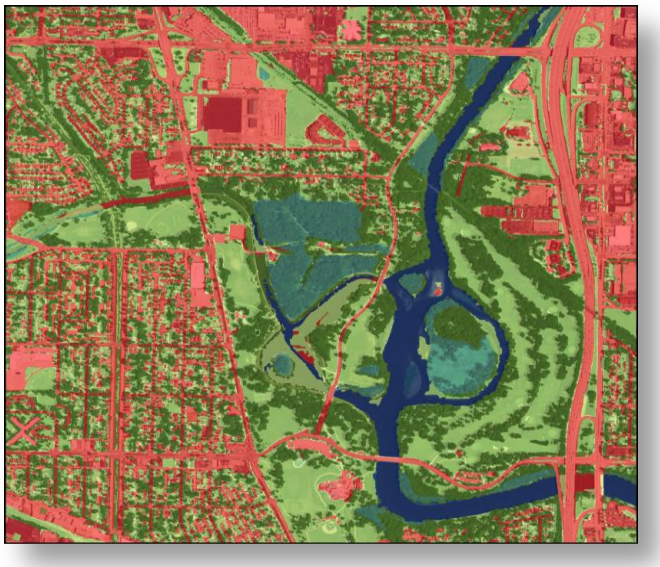
EnviroAtlas maps for community landcover data depict major landcover classes at a 1 meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale represented by 30-meter resolution landcover data and a higher 1-meter resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution (1-meter scale) urban land cover (ULC) map that quantifies the type and areal extent of the material at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in NLCD, but there are approximately 900 ULC pixels inside the footprint of one 30x30 meter NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary for sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers, and students. Some potential applications of this map include stormwater and urban heat island mitigation[1]; habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each land cover class has characteristic biophysical properties and



processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover within 15 m of roadway
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr) from filtration by trees

Urban land cover data show land cover patterns that control or influence human and ecosystem health in the urban landscape and support numerous lines of investigation. Metric information derived from this landcover data is summarized by census block groups. Levels of ecosystem services may be compared among different neighborhoods

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using the census block group reporting framework. Which streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.[2]

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparent land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation, and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP). NAIP characteristics include three visible and one near-infrared spectral bands, 1-meter spatial resolution, nation-wide availability on a three year update cycle, and low to no cost.

Researchers with the University of Arkansas, Center for Advanced Spatial Technologies (CAST), under contract to Oneida Total Integrated Enterprises (OTIE), utilized Object Based Image Analysis (OBIA) techniques and rule sets to classify the land cover for 66 of the 85 NAIP tiles, 19 of which included LiDAR data for building and tree classification. The remaining 19 tiles were processed at EPA using machine learning algorithms in a supervised classification. Six land cover classes were mapped: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, Agriculture, and Water. Ancillary data (NWI) were used to map two additional land cover classes: Woody and Emergent Wetlands. Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Milwaukee, Wisconsin land cover data has an overall accuracy of about 84 percent. Full accuracy results are reported in the map metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

A selection of resources related to landcover and community analyses is listed below. In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas meter scale land cover data for the Milwaukee, Wisconsin area was developed by University of Arkansas, Center for Advanced Spatial Technologies, Drew Pilant, EPA, and Charles Rudder, EPA Student Services Contractor. Drew Pilant and Charles Rudder created the fact sheet.

Selected Publications

1. Rosenzweig, C., W. Solecki, L. Parshall, S. Gaffin, B. Lynn, R. Goldberg, J. Cox, and S. Hodges. 2006. Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces. National Aeronautics and Space Administration, Washington, D.C.

2. Baker, J.P., D.W. Hulse, S.V. Gregory, D. White, J. Van Sickle, P.A. Berger, D. Dole, and N.H. Schumaker. 2004. Alternative futures for the Willamette River Basin, Oregon. *Ecological Applications* 14(2): 313–324.

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.

Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21.

Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

New Bedford, MA Land Cover

EnviroAtlas maps for community landcover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale represented by 30-meter resolution landcover data and a higher 1-meter resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution urban land cover (ULC) map that quantifies the type and areal extent of the material composition at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in National Land Cover Data (NLCD),[1,2] but at higher spatial resolution: there are approximately 900 ULC pixels inside the footprint of one 30x30 m NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary to sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers and students. Some potential applications of this map include: stormwater and urban heat island mitigation; habitat, wildlife corridors and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. Each land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

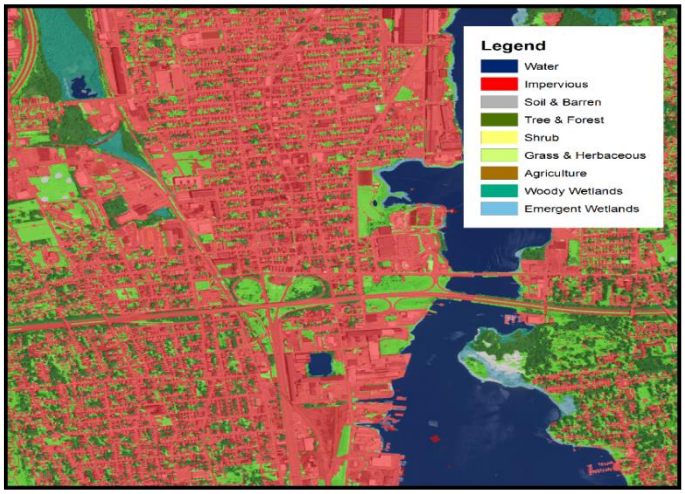

Figure 1 New Bedford, MA urban land cover overlaid on air photo. Each color represents a specific LC class. Note the fine spatial detail showing individual buildings, trees, and roads.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover within 15 m of roadway
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr) from filtration by trees.

Urban land cover data show land cover patterns that control or influence human and ecosystem health in the urban landscape and support numerous lines of investigation. Metric information derived from this landcover data is

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summarized by census block groups. Levels of ecosystem services may be compared among different neighborhoods using the census block group reporting framework. Which streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparent land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP).[3] NAIP characteristics include three visible and one near-infrared spectral bands, one meter pixel size, nation-wide availability on a three year update cycle, and low to no cost.

Machine learning, automated feature extraction software was used in supervised classification to identify six common land cover classes: Impervious Surfaces, Soil-Barren, Grass-Herbaceous, Tree-Forest, Agriculture, and Water. Ancillary data (NWI) were used to map two additional land cover classes: Wetlands (Woody and Emergent) and some water bodies.[4] Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The New Bedford, MA land cover data has an overall accuracy of about 92 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

To learn more about the societal benefits associated with land cover in general, there are many resources in the literature and on the internet. A small subset of these resources has been listed in the selected publications section below. In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas meter scale land cover data for the New Bedford, MA area was developed by Jeremy Baynes, EPA Student Services Contractor. Drew Pilant and Jeremy Baynes created the fact sheet.

Selected Publications

1. U.S. Geological Survey. 2013. National Land Cover Database (NLCD). Accessed March 2015.

2. 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.

3. U.S.D.A. Farm Service Agency. National Agriculture Imagery Program (NAIP). Accessed June 2016.

4. U.S. Fish and Wildlife Service. National Wetlands Inventory data. Accessed June 2016.

Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21

Paterson, NJ Land Cover

EnviroAtlas maps for community landcover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale represented by 30-meter resolution landcover data and a higher 1-meter resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution urban land cover (ULC) map that quantifies the type and areal extent of the material composition at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in National Land Cover Data (NLCD),[1,2] but at higher spatial resolution: there are approximately 900 ULC pixels inside the footprint of one 30x30 m NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary to sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers and students. Some potential applications of this map include: stormwater and urban heat island mitigation; habitat, wildlife corridors and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. Each land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

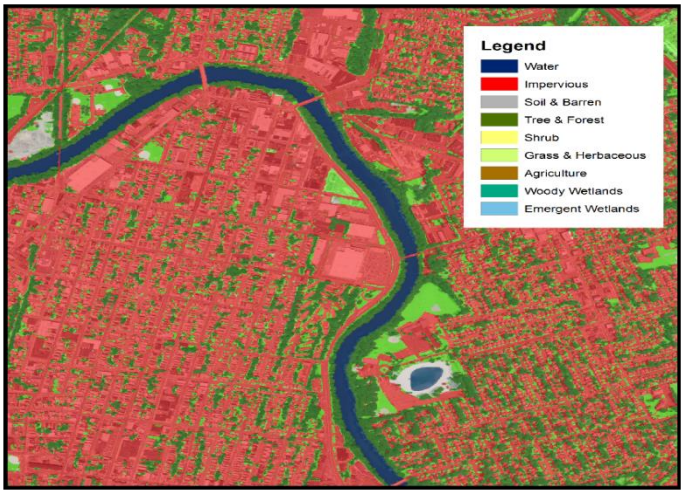

Figure 1 Paterson, NJ urban land cover overlaid on air photo. Each color represents a specific land cover class. Note the fine spatial detail showing individual buildings, trees, and roads.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
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Urban land cover data show land cover patterns that control or influence human and ecosystem health in the urban landscape and support numerous lines of investigation. Metric information

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derived from this landcover data is summarized by census block groups. Levels of ecosystem services may be compared among different neighborhoods using the census block group reporting framework. Which streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparent land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP).[3] NAIP characteristics include three visible and one near infrared spectral bands, one meter pixel size, nation-wide availability on a three year update cycle, and low to no cost.

Machine learning, automated feature extraction software was used in supervised classification to identify six common land cover classes: Impervious Surfaces, Soil-Barren, Grass-Herbaceous, Tree-Forest, Agriculture, and Water. Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Paterson, NJ land cover has an overall User's Accuracy of about 87 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

To learn more about the societal benefits associated with land cover in general, there are many resources in the literature and on the internet. A small subset of these resources has been listed in the selected publications section below. In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas meter scale land cover data for the Paterson, NJ area was developed by Jeremy Baynes, EPA Student Services Contractor and Drew Pilant, EPA. This fact sheet was written by Jeremy Baynes and Drew Pilant.

Selected Publications

1. U.S. Geological Survey. 2013. National Land Cover Database (NLCD). Accessed March 2015.

2. 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.

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Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21.

Phoenix, Arizona Land Cover

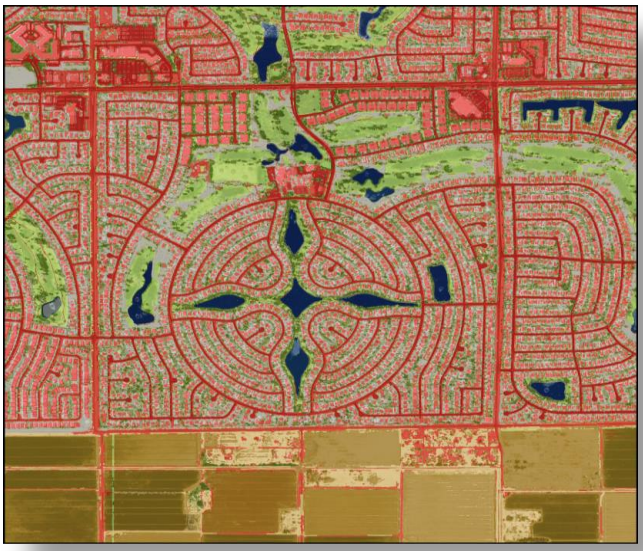
EnviroAtlas maps for community landcover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale represented by 30-meter resolution landcover data and a higher 1-meter resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution (1-meter scale) urban land cover (ULC) map that quantifies the type and areal extent of the material at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in NLCD, but there are approximately 900 ULC pixels inside the footprint of one 30x30 meter NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary to sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers, and students. Some potential applications of this map include stormwater and urban heat island mitigation[1]; habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each land cover class has characteristic biophysical properties and



processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
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Urban land cover data show land cover patterns that control or influence human and ecosystem health in the urban landscape and support numerous lines of investigation. Metric information derived from this landcover data is summarized by census block groups. Levels of ecosystem

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services may be compared among different neighborhoods using the census block group reporting framework. Which streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.[2]

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparent land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP). NAIP characteristics include three visible and one near-infrared spectral bands, 1-meter spatial resolution, nation-wide availability on a three year update cycle, and low to no cost.

Researchers with the Environmental Remote Sensing and Geoinformatics Lab (ERSG) at Arizona State University (ASU) utilized Object Based Image Analysis (OBIA) techniques and rule sets to classify the land cover for the Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER) project. ASU's classification had additional distinct classes (e.g., swimming pools, seasonal river, etc.) that were collapsed into seven land cover types: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, Shrub, Agriculture, and Water. The CAP LTER project area encompasses the majority of the EnviroAtlas Phoenix study area. EPA utilized a machine learning, automated feature extraction software for the area outside of CAP LTER project. Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. Full accuracy results are reported in the map 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 viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

A selection of resources related to landcover and community analyses is listed below. In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

The EnviroAtlas meter scale land cover data for the Phoenix, Arizona area was developed by Arizona State University ERSG Lab and supplemented by Matthew Dannenberg, EPA Student Services Contractor, and Drew Pilant, EPA. The fact sheet was written by Drew Pilant, EPA, and Jeremy Baynes, and Charles Rudder, EPA Student Services Contractors.

Selected Publications

1. Rosenzweig, C., W. Solecki, L. Parshall, S. Gaffin, B. Lynn, R. Goldberg, J. Cox, and S. Hodges. 2006. Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces. National Aeronautics and Space Administration, Washington, D.C.

2. Baker, J.P., D.W. Hulse, S.V. Gregory, D. White, J. Van Sickle, P.A. Berger, D. Dole, and N.H. Schumaker. 2004. Alternative futures for the Willamette River Basin, Oregon. *Ecological Applications* 14(2): 313–324.

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Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Pittsburgh, Pennsylvania Land Cover

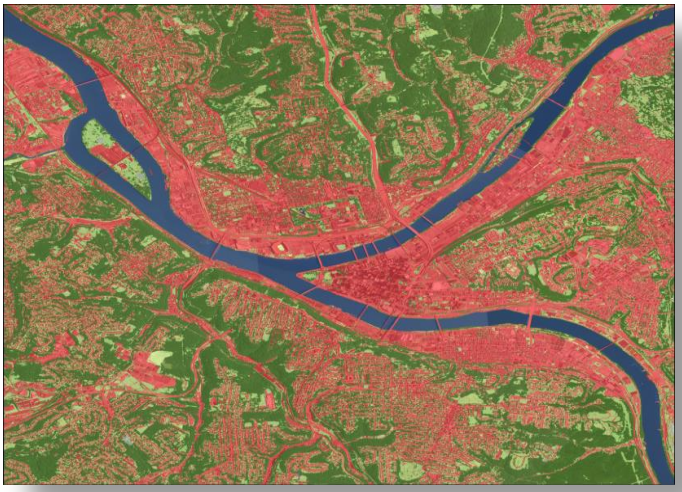
EnviroAtlas maps for community landcover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale represented by 30-meter resolution landcover data and a higher 1-meter resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution (1 meter scale) urban land cover (ULC) map that quantifies the type and areal extent of the material at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in NLCD, but there are approximately 900 ULC pixels inside the footprint of one 30x30 meter NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary for sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers, and students. Some potential applications of this map include stormwater and urban heat island mitigation[1]; habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each land cover class has characteristic biophysical properties and



processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

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streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.[2]

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparent land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation, and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP). NAIP characteristics include three visible and one near-infrared spectral bands, 1-meter spatial resolution, nation-wide availability on a three year update cycle, and low to no cost.

Machine-learning, automated feature extraction software was used in supervised classification to identify five common land cover classes: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, and Water. Ancillary data used included the PAMAP LiDAR Data of Pennsylvania and 3.2ft Digital Elevation Model of Pennsylvania. LiDAR derived data along with the DEM were used primarily in identifying tree canopy. Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Pittsburgh, Pennsylvania land cover data has an overall accuracy of about 86 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

A selection of resources related to landcover and community analyses is listed below. In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. Drew Pilant, EPA, and Jeremy Baynes, EPA Student Services Contractor, developed the EnviroAtlas meter scale land cover data for the Pittsburgh, Pennsylvania area and they also wrote the data fact sheet.

Selected Publications

1. Rosenzweig, C., W. Solecki, L. Parshall, S. Gaffin, B. Lynn, R. Goldberg, J. Cox, and S. Hodges. 2006. Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces. National Aeronautics and Space Administration, Washington, D.C.

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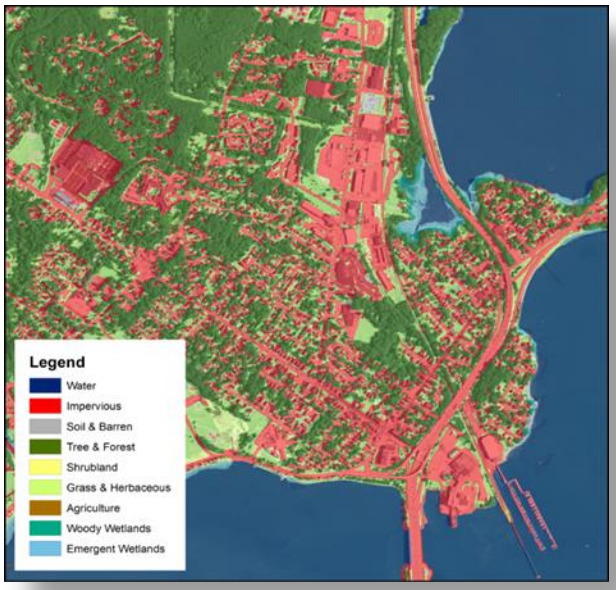
Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Portland, Maine Land Cover

EnviroAtlas maps for community landcover data depict major landcover classes at a 1 meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.



Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale represented by 30-meter resolution landcover data and a higher 1-meter resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution (1 meter scale) urban land cover (ULC) map that quantifies the type and areal extent of the material at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in NLCD, but there are approximately 900 ULC pixels inside the footprint of one 30x30 meter NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary for sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers, and students. Some potential applications of this map include stormwater and urban heat island mitigation[1]; habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover within 15 m of roadway
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr) from filtration by trees

Urban land cover data show land cover patterns that control or influence human and ecosystem health in the urban landscape and support numerous lines of investigation. Metric information derived from this landcover data is

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summarized by census block groups. Levels of ecosystem services may be compared among different neighborhoods using the census block group reporting framework. Which streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.[2]

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparent land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation, and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP). NAIP characteristics include three visible and one near-infrared spectral bands, 1-meter spatial resolution, nation-wide availability on a three year update cycle, and low to no cost.

Machine learning, automated feature extraction software was used in supervised classification to identify six common land cover classes: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, Agriculture, and Water. Ancillary National Wetlands Inventory (NWI) data were used to map two additional land cover classes, Woody and Emergent Wetlands and some water bodies. Hand editing was used as needed. Data were organized and manipulated in a GIS. Each city's metadata gives a full description of the remote sensing classification techniques.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Portland, Maine land cover data have an overall accuracy of about 87 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

A selection of resources related to landcover and community analyses is listed below. In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. Jeremy Baynes, EPA Student Services Contractor, and Drew Pilant, EPA, developed the EnviroAtlas meter scale land cover data for the Portland, Maine area and wrote the fact sheet.

Selected Publications

1. Rosenzweig, C., W. Solecki, L. Parshall, S. Gaffin, B. Lynn, R. Goldberg, J. Cox, and S. Hodges. 2006. Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces. National Aeronautics and Space Administration, Washington, D.C.

2. Baker, J.P., D.W. Hulse, S.V. Gregory, D. White, J. Van Sickle, P.A. Berger, D. Dole, and N.H. Schumaker. 2004. Alternative futures for the Willamette River Basin, Oregon. *Ecological Applications* 14(2): 313–324.

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.

Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21.

Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Portland, Oregon Land Cover

EnviroAtlas maps for community landcover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale represented by 30-meter resolution landcover data and a higher 1-meter resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution (1-meter scale) urban land cover (ULC) map that quantifies the type and areal extent of the material composition at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in National Land Cover Data (NLCD),[1,2] but at higher spatial resolution: there are approximately 900 ULC pixels inside the footprint of one 30x30 m NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary to sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers and students. Some potential applications of this map include stormwater and urban heat island mitigation; habitat, wildlife corridors and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns and relationships in the landscape. Each land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

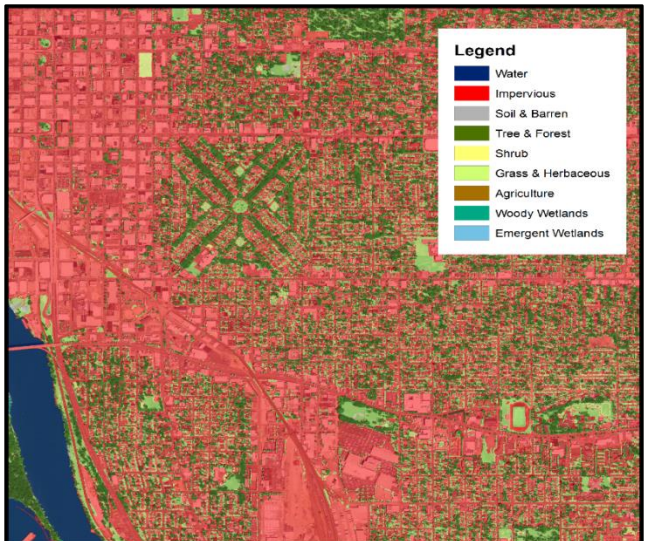

Figure 1 Portland, OR urban land cover overlaid on air photo. Each color represents a specific LC class. Note the fine spatial detail showing individual buildings, trees, and roads

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover within 15 m of roadway
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr) from filtration by trees

Urban land cover data show land cover patterns that control or influence human and ecosystem health in the urban landscape and support numerous lines of investigation.

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Metric information derived from this landcover data is summarized by census block groups. Levels of ecosystem services may be compared among different neighborhoods using the census block group reporting framework. Which streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparent land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation, and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP).[3] NAIP characteristics include three visible and one near-infrared spectral bands, one meter pixel size, nation-wide availability on a three year update cycle, and low to no cost. Additionally, several LiDAR datasets acquired from NOAA Digital Coast were used as ancillary datasets to aid in classification.

A random forest statistical method was used in supervised classification to identify six common land cover classes: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, Agriculture, and Water. Ancillary data were used to map two additional land cover classes: Wetlands (Woody and Emergent) and some water bodies (U.S. Fish and Wildlife Service, 2013).[4] Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Portland, Oregon land cover data have an overall user's accuracy of about 79 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

To learn more about the societal benefits associated with land cover in general, one can find many resources in the literature and on the internet. A small subset of these resources has been listed in the selected publications section below.

In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

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

Selected Publications

1. U.S. Geological Survey. 2013. National Land Cover Database (NLCD). Accessed March 2015.

2. 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.

3. U.S.D.A. Farm Service Agency. National Agriculture Imagery Program (NAIP). Accessed June 2016.

4. U.S. Fish and Wildlife Service. National Wetlands Inventory data. Accessed June 2016.

Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Tampa, Florida Land Cover

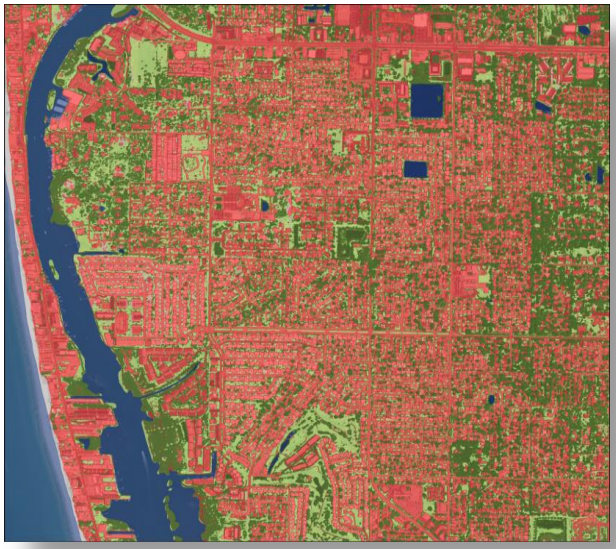
EnviroAtlas maps for community landcover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. EnviroAtlas presents landcover information at two major spatial scales: a national scale represented by 30-meter resolution landcover data and a higher 1-meter resolution for selected communities. Existing National Land Cover Data (NLCD) processed at 30-meter spatial resolution are too coarse to measure many urban phenomena. To support community mapping activities, the EnviroAtlas Team developed a high spatial resolution (1-meter scale) urban land cover (ULC) map that quantifies the type and areal extent of the material composition at earth's surface, such as trees, grass, impervious surfaces, water and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, and they represent the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to those in National Land Cover Data (NLCD), but at higher spatial resolution: there are approximately 900 ULC pixels inside the footprint of one 30x30 meter NLCD pixel.

Land cover is the ecosystem matrix in which cities are embedded. Land cover data are necessary for sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers, and students. Some potential applications of this map include stormwater and urban heat island mitigation,[1] habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology.

Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each



land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other EnviroAtlas data layers to assess the distribution of natural resources and their benefits to community health and well-being. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover within 15 m of roadway
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr) from filtration by trees

Urban land cover data show land cover patterns that control or influence human and ecosystem health in the urban landscape and support numerous lines of investigation. Metric information derived from this landcover data is summarized by census block groups. Levels of ecosystem

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services may be compared among different neighborhoods using the census block group reporting framework. Which streets need more trees? What areas are mostly composed of impervious surfaces and subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.[2]

Note: The Transparency Slider (found in the i-button drop down menu next to the map layer name) may be used to see through the land cover data and explore how the land cover relates to aerial imagery and other EnviroAtlas layers. Experiment with multiple layer blending using 50–100% transparent land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation, and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP). NAIP characteristics include three visible and one near-infrared spectral bands, 1-meter spatial resolution, nation-wide availability on a three year update cycle, and low to no cost.

Machine learning, automated feature extraction software was used in supervised classification to identify four land cover classes: Impervious Surface, Soil-Barren, Grass-Herbaceous, and Tree-Forest. Ancillary wetland National Hydrography Dataset (NHD) GIS layers were used in delineating surface waters and woody and emergent wetlands. Object-based image analysis software was used with rule sets to identify agricultural fields. Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Tampa, Florida land cover data have an overall accuracy of about 71 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

A selection of resources related to landcover and community analyses is listed below. In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

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. Drew Pilant and Matthew Dannenberg wrote the fact sheet.

Selected Publications

1. Rosenzweig, C., W. Solecki, L. Parshall, S. Gaffin, B. Lynn, R. Goldberg, J. Cox, and S. Hodges. 2006. Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces. National Aeronautics and Space Administration, Washington, D.C.

2. Baker, J.P., D.W. Hulse, S.V. Gregory, D. White, J. Van Sickle, P.A. Berger, D. Dole, and N.H. Schumaker. 2004. Alternative futures for the Willamette River Basin, Oregon. *Ecological Applications* 14(2): 313–324.

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.

Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21.

Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Woodbine, Iowa Land Cover

EnviroAtlas maps for community land cover data depict major landcover classes at a 1-meter resolution for selected communities. The high resolution urban landcover data provides a base layer for the development of metrics and analyses that illustrate the benefits of natural resources to local communities.

Why is community land cover important?

Land cover data represent the surface components of the land that are physically present and visible; the use of land cover data provides a means to examine landscape patterns and characteristics. This layer is a high spatial resolution urban land cover (ULC) map that quantifies the type and areal extent of the material composition at earth's surface, such as trees, grass, impervious surfaces, water, and barren land. It is a foundational layer for the EnviroAtlas community component that serves as input to approximately 85 sustainability and ecosystem services data layers. These ULC data are derived from one-meter-pixel aerial photos, representing the detailed biophysical landscape of urban life and infrastructure. The ULC classes are similar to National Land Cover Data (NLCD),[1,2] but at a higher spatial resolution: there are approximately 900 ULC pixels inside the footprint of one 30x30 m NLCD pixel.

Land cover is the foundation of the terrestrial biosphere, the zone of life on land. Land cover is the ecosystem matrix of surface materials in which cities are embedded. Land cover data are necessary for sound urban planning and sustainable development. Anticipated users of these data include city and county environmental decision makers, water authorities, wildlife and natural resource managers, citizens, teachers and students. Some potential applications of this map include: stormwater and urban heat island mitigation; habitat, wildlife corridors, and riparian buffers; recreation and access to green space; urban forestry; conservation; and urban landscape ecology. Land cover data at this high spatial resolution (1 m pixel) are rare. Created from aerial photography, the EnviroAtlas ULC data present a "birds-eye" view that can help identify important features, patterns, and relationships in the landscape. Each land cover class has characteristic biophysical properties and processes that contribute to a healthy urban environment. The importance of high resolution landcover data is to provide a detailed picture of the urban environment and its ecosystem matrix for analysis of multiple ecosystem services metrics.

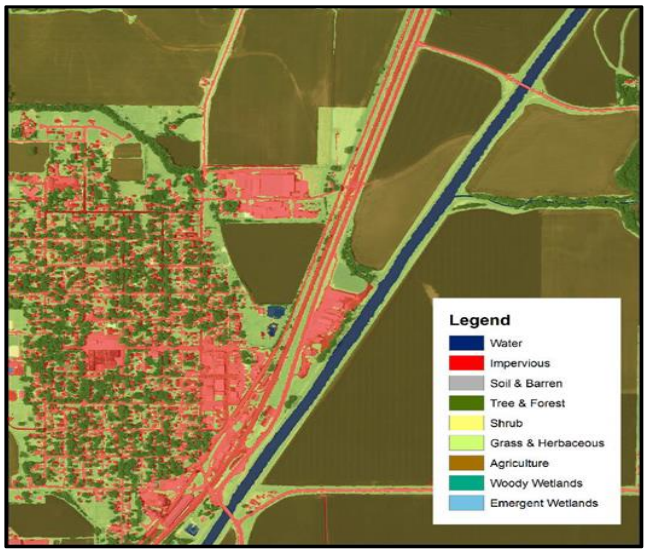

Figure 1 Woodbine, IA urban land cover overlaid on air photo. Each color represents a specific LC class. Note the fine spatial detail showing individual buildings, trees, and roads.

How can I use this information?

The ULC data can be used alone or combined visually and analytically with other GIS layers. Approximately 85 EnviroAtlas data layers and metrics incorporate meter-scale urban land cover in their computation, including:

- Total carbon stored in above ground biomass (mt)
- Reduction in annual stormwater runoff (m^3/yr)
- Value of asthma exacerbation cases avoided due to sulfur dioxide removed ($/yr)
- Percent tree cover near busy roadways
- Reduction in median load of nitrites and nitrates, phosphorous, and total suspended solids (kg/yr)

This layer shows land cover patterns that control or influence human and ecosystem health in the urban landscape, and supports numerous lines of investigation. Which streets need more trees? What areas are mostly impervious surface and subject to urban heat island and stormwater runoff effects? Do urban streams have healthy vegetated buffers? Current landcover data is also useful for analysis of future development scenarios—for example, envisioning planned development alternatives with current policies or more or less stringent policies and development pressures.

Use the transparency slider (in the dropdown list from the **i**-button to the right of the map layer name) to explore how

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land cover relates to imagery and other EnviroAtlas layers. Experiment with multiple layer blending using variable-transparency land cover overlaid on an imagery basemap.

How were the data for this map created?

These data were generated from digital image processing, air photo interpretation and supervised classification of aerial photography from the United States Department of Agriculture (USDA) National Agricultural Imagery Program (NAIP).[3] NAIP characteristics include three visible and one near infrared spectral bands, one meter pixel size, nation-wide availability on a three year update cycle, and low to no cost.

Machine learning, automated feature extraction software was used in supervised classification to identify six common land cover classes: Impervious Surface, Soil-Barren, Grass-Herbaceous, Tree-Forest, Agriculture, and Water. Ancillary data were used to map two additional land cover classes: Wetlands (Woody and Emergent) and some water bodies.[4] Hand editing was used as needed. Data were organized and manipulated in a GIS. A full description of the remote sensing classification techniques is given in each city's metadata.

What are the limitations of these data?

All land cover maps are, by their nature, imperfect, and the metrics generated from land cover maps cannot be taken as absolute truth, but as the best estimation of that truth based on the best available data. An accuracy assessment was conducted using approximately 100 photo-interpreted reference points per class. The Woodbine, Iowa land cover has an overall User's Accuracy of about 87 percent. Full accuracy results are reported in the map metadata. Accuracy information for the source data sets can be found on their respective web sites and metadata.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. To acquire the imagery data (NAIP), wetland data (NWI), or water data (NHD) used to generate this land cover, please visit the respective web sites for those datasets.

Where can I get more information?

There are many resources available in the literature and on the internet to learn more about the societal benefits associated with land cover. A small subset of these resources has been listed in the selected publications section below.

In-depth information on the relationships between urban ecosystems, such as green space and human health and well-being, can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The EnviroAtlas meter scale land cover data for the Woodbine, IA area was developed by Charles Rudder, EPA Student Services Contractor and Drew Pilant, EPA. Drew Pilant and Charles Rudder created the fact sheet.

Selected Publications

1. U.S. Geological Survey. 2013. National Land Cover Database (NLCD). Accessed March 2015.

2. 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.

3. U.S. Department of Agriculture, Farm Service Agency, 2013, Aerial Photography Field Office, NAIP Imagery. Accessed October 2016.

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

Myeong, S., D.J. Nowak, P.F. Hopkins, and R.H. Brock. 2001. Urban cover mapping using digital, high-spatial resolution aerial imagery. *Urban Ecosystems* 5: 243–256.

Lockaby, B.G., D. Zhang, J. McDaniel, H. Tian, and S. Pan. 2005. Interdisciplinary research at the urban-rural interface: The WestGA Project. *Urban Ecosystems* 8:7–21.