



ATtILA for ArcGIS Pro

EPA's Analytical Tools Interface for Landscape Assessments ([ATtILA](#)) is an ArcGIS Pro toolbox that calculates many landscape and landscape/human interaction metrics (measurements). The metrics are derived from algorithms using combinations or overlays of spatial data. The toolbox accepts a broad range of input data, and it may be used across all landscape types and geographic regions. ATtILA contains three toolsets described below and a suite of supporting utilities.

What are ATtILA's toolsets and how can they be used?

Each toolset contains tools for calculating individual landscape metrics. For many of the tools, the analysis begins with the user identifying their reporting units of interest. For example, the user might want to know the percentage of impervious cover for every county in a state. Reporting units can be [watersheds](#), hydrological unit codes ([HUCs](#)), ecological regions, census geographies, political units, or any other areal units of interest.

Landscape Characteristics Toolset

The Landscape Characteristics toolset calculates metrics that characterize the composition and spatial configuration of the landscape. The Landscape Characteristics toolset contains the following tools: Land Cover Proportions, Land Cover on Slopes Proportions, Land Cover Diversity, Neighborhood Proportions, Core and Edge Metrics, and Patch Metrics.

Many landscape analyses include identifying the **Land Cover Proportions** (e.g., forest, development, agriculture) within reporting units. Land cover proportions can tell us a lot about likely conditions across small and large regions; they can help us assess risk from hazards, prioritize areas for use, conservation, or restoration, and help us assess change over time.

The **Land Cover on Slope Proportions** tool calculates percentages of land cover classes on slopes greater than or equal to a user input slope threshold (say 9%). Though the tool may be used for a variety of disturbances in hilly terrain, it is commonly used to calculate the amount of agriculture on steeper slopes as a predictive indicator of water quality. This metric may be used to locate candidate areas for conservation and restoration. Restoration of natural vegetation on steeper



slopes helps to reduce erosion and sedimentation, improve wildlife habitat, and increase biodiversity and [connectivity](#).¹

Measures of landscape diversity attempt to capture the number (richness) and distribution (evenness) of land cover types in a study area. The **Land Cover Diversity** tool calculates several landscape diversity indices: the [Simple diversity](#) or Richness index, the [Shannon-Weiner](#) index, the [Standardized Shannon-Weiner](#) index, and the [Simpson's](#) index. Areas with a higher number of landscape types that are evenly distributed are considered the most diverse. Landscape diversity metrics, along with core, edge, and patch metrics provide a view of the availability of terrestrial and aquatic wildlife habitat and the degree of fragmentation and development present in each reporting unit.

The **Neighborhood Proportions** tool calculates the area percentage of selected land cover classes within a neighborhood (i.e., a square area surrounding cell or pixel). The size of the square is determined by the user. For example, this local neighborhood land cover type analysis can be useful to find impervious cover hotspots where urban heat island may be an issue or for assessing local access to green space.

Disturbance-sensitive wildlife species typically require larger minimally-disturbed core areas to prosper, while more tolerant species may successfully inhabit edge environments in more developed areas. The **Core and Edge Metric** tool calculates the edge-to-area ratio within each reporting unit for selected land cover types. The core and edge tool, along with

patch metrics (discussed below), may be used to assess fragmentation, terrestrial and aquatic wildlife habitat availability, and connectivity within a study area.

Patches of natural land cover of varying sizes, both upland and [riparian](#), are important for biodiversity, and they provide ecosystem services in the form of water purification, nutrient filtration, temperature moderation, and flood storage. The **Patch Metrics** tool calculates metrics such as number of land cover patches, average patch size, and patch density. Patch metrics may be determined for any land cover type. They are often used to examine forest fragmentation, habitat availability, and habitat connectivity corridors in a natural or developed landscape (see image).¹

People in the Landscape Toolset

People derive benefits from their surrounding landscapes, but human land uses can also stress the environment. The **People in the Landscape** toolset contains tools that measure both benefits and stressors; they include Land Cover Coefficient Calculator, Population Density Metrics, Population in Floodplains Metrics, Population Land Cover Views, Facility Land Cover Views, Road Density Metrics, and Intersection Density.

The **Land Cover Coefficient Calculator** tool estimates nitrogen (N) and phosphorus (P) loading and runoff from the landscape including impervious surfaces (e.g., streets and rooftops). Coefficients (weights or multipliers based on literature review) for various land cover classes are applied to a land cover grid to estimate the effects of runoff from various sources (e.g., agriculture, lawns, or golf courses) on local or regional water quality. These nonpoint source pollutants negatively influence aquatic communities and water quantity, quality, clarity, and oxygen content. Users may identify reporting units that can be improved with the addition of [green infrastructure](#) to slow and filter agricultural or urban runoff, cool water temperatures, capture air pollutants, and provide wildlife corridors.

The **Population Density Metrics** tool calculates metrics such as population count, population density (e.g., number of people per km²), and percent population change by reporting unit. Estimating population change for two different time periods can help to identify reporting units experiencing high rates of growth with accompanying impacts. The **Population Density Metrics** tool can also be used to examine other changes over time by substituting other variables (like forest cover) for population count.

Flood hazards pose risks to property, drinking water sources, and public health. The **Population in Floodplains Metrics** tool counts total population living in the floodplain area within the reporting unit and calculates the percentage of total population living in the floodplain. These metrics can be used

by citizens, planners, and public health professionals to identify residential areas most at risk for flooding. The **Population in Floodplains Metrics** tool can be combined with Riparian Characteristics tools to find other factors that either increase flood risk (like impervious surfaces in the floodplain) or mitigate flood risk (natural cover, e.g., wetlands and riparian tree cover).

Community neighborhoods may show disparities in the distribution of amenities such as parks and tree-lined streets that provide mental and physical health benefits. The tool, **Population Land Cover Views**, calculates metrics estimating the residential populations (both total and percent) in each reporting unit that have or lack potential views of selected land cover types (e.g., parks, street trees, or waterbodies) within a given distance from their location. With these metrics, users can assess neighborhoods that have or lack access to green space that provides opportunities for physical activity and community social interaction.

The **Facility Land Cover Views** tool counts the number of selected facilities in each reporting unit with less than or equal to a threshold percentage of selected land cover types within a given distance. The land cover types, percentage threshold value, and buffer distance are provided by the user. For example, studies have shown that window views of green space from hospitals, schools, and daycare centers have been linked to positive health effects, stress reduction, and increased attention span and cognitive function in those using the facilities.^{2,3}

Roads are a critical element of human infrastructure, but they can negatively impact public health and the natural environment. The **Road Density Metrics** tool includes metrics for road density, roads near streams, and roads crossing streams. These road metrics can be used as indicators of the effects of roads on terrestrial and aquatic communities. The largest overall effect of road density on ecosystems is habitat fragmentation into smaller patches, bringing increased disturbance, predation, and isolation to wildlife species, ultimately leading to reduced wildlife populations.⁴ A roads-near-streams metric indicates the relative extent of roads in proximity to streams, potentially adding pollutants to streams, altering drainage patterns, and interrupting the mitigating effects of riparian buffer vegetation.⁵ A roads-crossing-streams metric estimates stream exposure within the reporting unit to bridges that can add sediment and pollutants or culverts that can clog with sediment and debris to block or alter drainage patterns or act as barriers to fish passage.

The **Intersection Density** tool estimates the intersection density of roads within a given search radius for any pixel in the output raster map. Intersection density is a measure of interest to city planners because higher intersection density tends to slow traffic speed, increasing safety and promoting

walkability. In addition, intersection density may be overlaid by green space to assess where communities may benefit from additional tree cover.

Riparian Characteristics Toolset

Forest land and other natural cover adjacent to waterbodies ([riparian buffers](#)) help protect terrestrial and aquatic wildlife habitat, water quality, and flow (water quantity). Maintaining forest cover in stream buffers benefits water quality at the site as well as downstream. Natural cover in riparian buffers delays and stores flood water and filters significant quantities of sediment, nutrients, and other pollutants from agricultural fields and urban stormwater runoff.⁶ The **Riparian Land Cover Proportions** tool calculates percentages of land cover types within the riparian buffer area, a width on both sides of the stream defined by the user. Though buffer widths of 30m are common, a user may want to choose a buffer width that is optimal for a target group of wildlife species, say 60m for interior bird species or wildlife movement corridors. One can use this tool to find reporting units where conserving or restoring forest cover in riparian buffers would help improve water quality and riparian habitats.

As noted for the Population in Floodplain Metrics tool, ATtILA's Riparian Characteristics toolset may help to identify land cover in the riparian buffer that may either increase or mitigate flood risk. The **Floodplain Land Cover Proportions** tool calculates the percentage of floodplain area within a reporting unit classified as selected land cover types. A user may examine the extent of developed area or impervious surfaces to find areas of highest flood risk or combine natural cover classes like forest, shrubland, and wetland, that slow and store floodwater and filter out contaminants.

Stream density varies from watershed to watershed depending on underlying geology and soils. Relatively impermeable soils like shale-derived soils or clay will promote higher runoff and stream density, while highly permeable sandy soil

will produce fewer stream channels. The **Stream Density Metrics** tool calculates stream density metrics based on input vector line hydrography dataset(s) for each reporting unit polygon. Default metrics include area of the reporting unit (km²), total stream length (km) and stream density (km/km²) within the reporting unit. In addition, stream length and density metrics can be calculated by stream order. These basic stream metrics are essential to study and manage water availability for drinking water, wildlife habitat, fisheries, irrigation, recreation, and public health.

Research and management activities like those listed above often require stream sampling to assess local or regional water quality, riparian and stream habitat condition, and fish and aquatic insect abundance. The **Sample Point Land Cover Proportions** tool provides the land cover proportions within the immediate area surrounding a point feature, for example, each one of a collection of stream survey sampling points. The tool produces an output table of the land cover proportions within the upslope/upstream portion of a sample point circle with a user-specified radius. The downslope portion of the buffer circle is eliminated. This metric allows the user to compare the potential contributions from the land cover types of the entire upslope watershed (found using the Landscape Characteristics toolset) with those found within the immediate area of the upslope circle surrounding each sample point.

Where can I get more information?

Selected references related to the fact sheet narrative are listed below. The ATtILA for ArcGIS Pro toolbox may be downloaded at the [ATtILA](#) website. For more information on data, toolsets, and metrics, see the ATtILA [Wiki](#).

Acknowledgments

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Selected Publications

1. Bennett, A.F. 2003. [Linkages in the landscape: The role of corridors and connectivity in wildlife conservation](#). *International Union for Conservation of Nature*, Gland, Switzerland and Cambridge, United Kingdom. 254 p.
2. Heschong Mahone Group. 2003. [Windows and classrooms: Student performance and the indoor environment](#). Technical Report P500-03-082-A-7, State of California Energy Commission, Sacramento, California.
3. Ulrich, R.S. 1984. [View through a window may influence recovery from surgery](#). *Science* 224(4647): 420–421.
4. Heilman, G.E., J.R. Strittholt, N.C. Slosser, and D.A. Dellasala. 2002. [Forest fragmentation of the conterminous United States: Assessing forest intactness through road density and spatial characteristics](#). *BioScience* 52(5): 411–422.
5. Jones, J.A., F.J. Swanson, B.C. Wemple, and K.U. Snyder. 2000. [Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks](#). *Conservation Biology* 14(1):76–85.
6. Mayer, P.M., S.K. Reynolds, M.D. McCutchen, and T.J. Canfield. 2006. [Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: A review of current science and regulations](#). EPA/600/R-05/118. U.S. Environmental Protection Agency, Cincinnati, Ohio.