Land Cover Change Analysis and Urban Tree Canopy Assessment in North Carolina

Trees, and their natural environment, provide many economic, environmental, and social benefits to the people and communities around where they grow.

Introduction

As North Carolina increases in population, and land uses continue to change, it is important to be aware of the impact that change has on both the forested lands and the services that they provide to all North Carolinians. Determining the impact of development and knowing the options for existing resources are essential for planners and others.

Good land management decisions recognize the interdependence of healthy people, strong economies, and vibrant, intact and biologically diverse landscapes

The increasing accessibility of tools for local government planners, such as canopy assessments, provides previously unavailable information to determine the effects of proposed landscape change. Data that describes the existing land cover, and how it functions to manage air and water quality, and the economic value of those services, can now be included in the costs and benefits of any planning process. This can help ensure that the priorities and values of the entire community are addressed.

- reduce energy use & costs
- increase business traffic
- increase property values & tax revenues
- reduce stormwater utility costs

ECONOMIC

- improve air & water quality
- reduce stormwater runoff
- moderate local climate
- conserve natural habitat & linkages

ENVIRONMENT

- reduce violence
- connect to nature
- improve health & recovery
- provide privacy & reduce noise

SOCIAL

The economic, environmental, and social value of natural resources can be easy to overlook when making land-use decisions. But, just as the gray infrastructure of roads, bridges, power lines, pipelines, and sewer systems are planned, so should the supporting and surrounding ***green infrastructure*** of trees, water, soil and working lands for forestry and agriculture. Residents, businesses, and local governments all benefit when planners facilitate development in ways that reduces development impacts on the landscape.

The work of the natural landscape can be accurately measured and converted into an economic equivalent called an ecosystem service. ***Ecosystem services*** are those positive benefits nature provides us, generally for free, that are essential for a thriving community. They include clean air and water, recreational opportunities, beautiful vistas, natural heritage sites, and stormwater remediation as well as healthy foods and places to rest the soul and recuperate.

When ecosystem services are disturbed by development, unanticipated changes can occur in the natural functions of the land. But, if land planning begins within the context of a local ecological system, development can be channeled into the most suitable areas, while environmental functions are protected, saving money and energy.

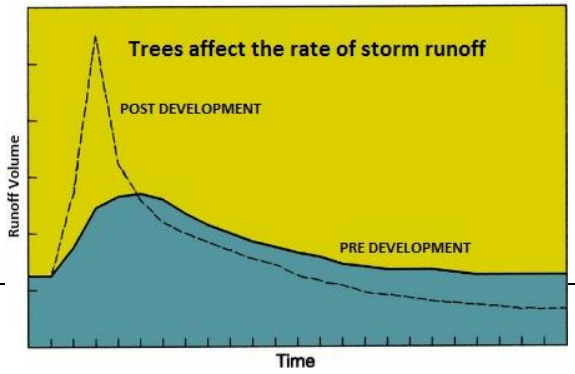
ECOSYSTEM SERVICES PROVIDED BY TREES and the NATURAL ENVIRONMENT

Air pollution: Trees and vegetation capture particulate matter and gases such as ozone, sulfur and nitrogen dioxides and carbon monoxide. Large healthy trees with trunks greater than 30 inches in diameter remove approximately 70 times more air pollution annually (3 lbs/yr) than small healthy trees with trunks less than 3 inches in diameter (0.04 lbs/yr).

Carbon storage: All plants use carbon for building cells and growing, keeping the carbon stored as long as the plant is intact. Large healthy trees greater than 30 inches in diameter sequester approximately 90 times more carbon yearly than small healthy trees less than 3 inches in diameter. Trees with large mature canopies store approximately 1000 times more carbon than trees with small mature canopies, over their lives.

Water quality and stormwater mitigation: Trees and vegetation intercept water physically, slowing stormwater flows. This reduces flooding and allows water to infiltrate into the ground for groundwater recharge.

The Effects of Urban Trees on Air Quality, David J. Nowak. USDA Forest Service. Syracuse. NY 2002



Reporting Ecosystem Services

Land Cover Change Analysis and Urban Tree Canopy Assessment provides valuable information for communities and provides the following resources for planning:

- A description of the geographic information system (GIS) data sets assembled for the project
- The methodology used to convert aerial imagery into land cover types
- A description of the engineering and scientific formulas used to analyze the data
- Ecosystem services calculations
- A description of the technical analysis methods used

What is GIS? *A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.*

GIS allows us to view, understand, question, interpret, and visualize data in many ways to reveal relationships, patterns, and trends, in the form of maps (www.esri.com).

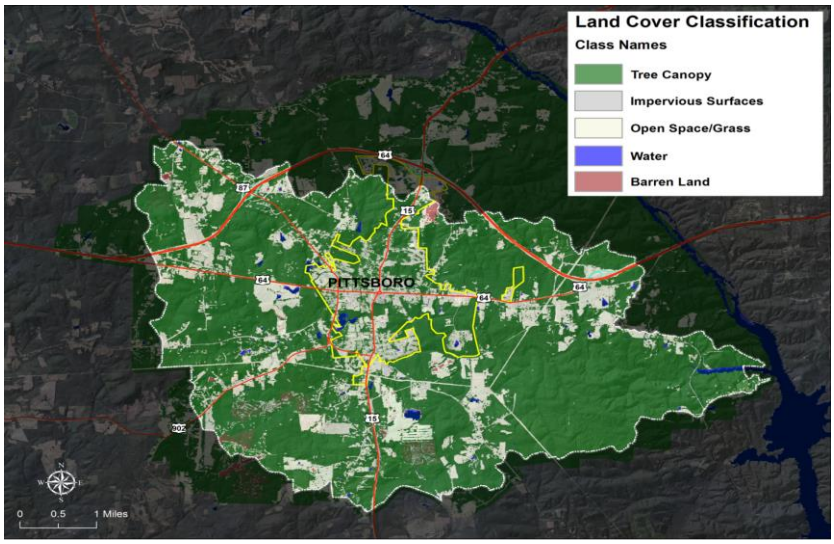
In addition to producing a written report, an ecological assessment should result in a GIS dataset that includes:

- Georeferenced (spatial) data extracted from satellite and aerial imagery, as well as, information describing the area's soil, water and air which is available from government agencies.

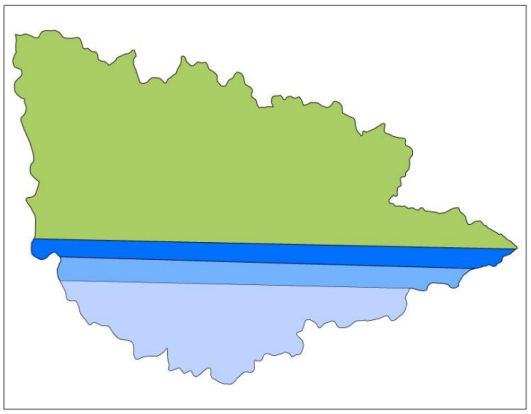
- Landsat imagery (NASA satellite) that has been classified, using the USGS methodology, to National Land Cover Data (NLCD) standards for the year 2013.
- High-resolution aerial imagery from the National Agricultural Imagery Program that has been classified at 1-3 meter resolution, depending on the commuity's needs.
- Canopy assessment data can then be merged into the community's zoning data provided by the community and/or county.

Robeson Creek Example

When ecological units, such as watersheds, are used to organize the landscape the impact of development can be better seen and more effectively planned. For a local example in Pittsboro, NC, consider the Robeson Creek watershed. With development that takes into account the green infrastructure of trees, water, soil and working lands for forestry and agriculture, it is possible for the Robeson Creek watershed to maintain the natural benefits of the system to clean water, and to ultimately meet the Total Maximum Daily Load (TMDL) requirements of the EPA. The ecosystem services provided by the green infrastructure reduce the required expenditures necessary for the community. Otherwise, man-made gray infrastructure must be built and maintained to provide the same services.



Watershed in 2012: An increase of 20% in impervious surface would be like adding to the Robeson Creek watershed: a 4-lane divided highway with shoulders (66' total width) 395 miles long (from Morehead City to Asheville); a 30% increase, 595 miles (from Raleigh to Orlando, FL); 40%, 790 miles (Raleigh to Portland, ME).



40% increase = 6,798 acres
30% increase = 5,217 acres
20% increase = 3,636 acres

A visual representation of the area of Robeson Creek Watershed impacted if impervious surfaces were increased by 20%, 30% or 40%.

Development in neighboring Chapel Hill has as much as 70% impervious surface through its traditionally designed developments, with the associated access roads and other infrastructure.

A scenario of the existing Robeson Creek watershed which currently has only 3% impervious surfaces was modeled to calculate 20%, 30%, and 40% changes in land cover from forest to impervious surfaces such as rooftops, roads, and parking lots. These three scenarios provide a context for considering the impact of different degrees of change. At the present time 78% of Robeson Creek watershed that is within Pittsboro's ETJ is forested.

The results of the ecosystem service analysis of the Robeson Creek scenario are given in the table below. In addition to showing the decrease in annual pounds of air pollution and cubic feet of stormwater stored, the table shows the corresponding *decrease* in money saved by the community when forestland is replaced with an equal area of impervious surfaces. For instance replacing 40% forestland in the watershed with rooftops, roads, and parking lots, results results in 40 million cubic feet of stormwater that will have to be accounted for with storm sewers and water retention areas. Also, a conversion of 40% of forestland results in an annual loss of approximately $42 million to the community of combined stormwater storage and air pollution removal services.

Pittsboro ETJ Ecosystem Analysis Scenario for Robeson Creek Watershed

15,809 acres	Trees	Air Pollution Removal		Carbon (tons stored)		Stormwater	
	acres	Lbs/year	Value $	Total	Per Year	Saved (ft^3)	Value @ $3/$ft^3$
Pittsboro – ETJ 2012	12,054	1,171,202	3,252,285	518,698	4,038	102,936,155	$308,808,465
Impervious 20%	8,885	863,263	2,397,175	382,319	2,976	89,442,649	$268,327,947
Impervious 30%	7,304	709,657	1,970,632	314,290	2,447	76,632,358	$229,897,074
Impervious 40%	5,723	556,052	1,544,088	246,262	1,917	62,799,572	$188,398,716

*Based on the Urban Hydrology of small Watershed model (TR-55) for stormwater runoff and the Urban Forest Effects (UFORE) for air pollution and carbon. See technical report for more information.

By utilizing a planning process that includes the goal of preserving the function of the natural system as g*reen infrastructure* it is possible to maintain the important ecosystem services that this natural system provides. Ecosystem analysis data can help guide decision-makers in identifying important green infrastructure resources and provide measures to evaluate the value of the services provided to the community.

American Forests estimates that trees in the nation's metropolitan areas contribute $400 billion in stormwater retention by eliminating the need for expensive stormwater facilities.

For further details on how the forest provides a valuable resource, you can access the report *Pittsboro, NC: Land Cover Change Analysis and Urban Tree Canopy Assessment* as completed in 2013 for for the Town of Pittsboro as part of the Planning Tools for Pittsboro Project, on the Chatham Conservation Partnership wikispace: https://chathamconservation.wikispaces.com

GLOBAL ecosystem CENTER

CHATHAM CONSERVATION PARTNERSHIP

NORTH CAROLINA Wildlife RESOURCES COMMISSION

BIOCENOSIS

NORTH CAROLINA FOREST SERVICE NC

Funding for this project was provided in part through the Urban & Community Forestry Program of the North Carolina Forest Service, Department of Agriculture and Consumer Services, in cooperation with the USDA Forest Service, Southern Region.