Urban Tree Canopy Assessment

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Animation instructions: N/A

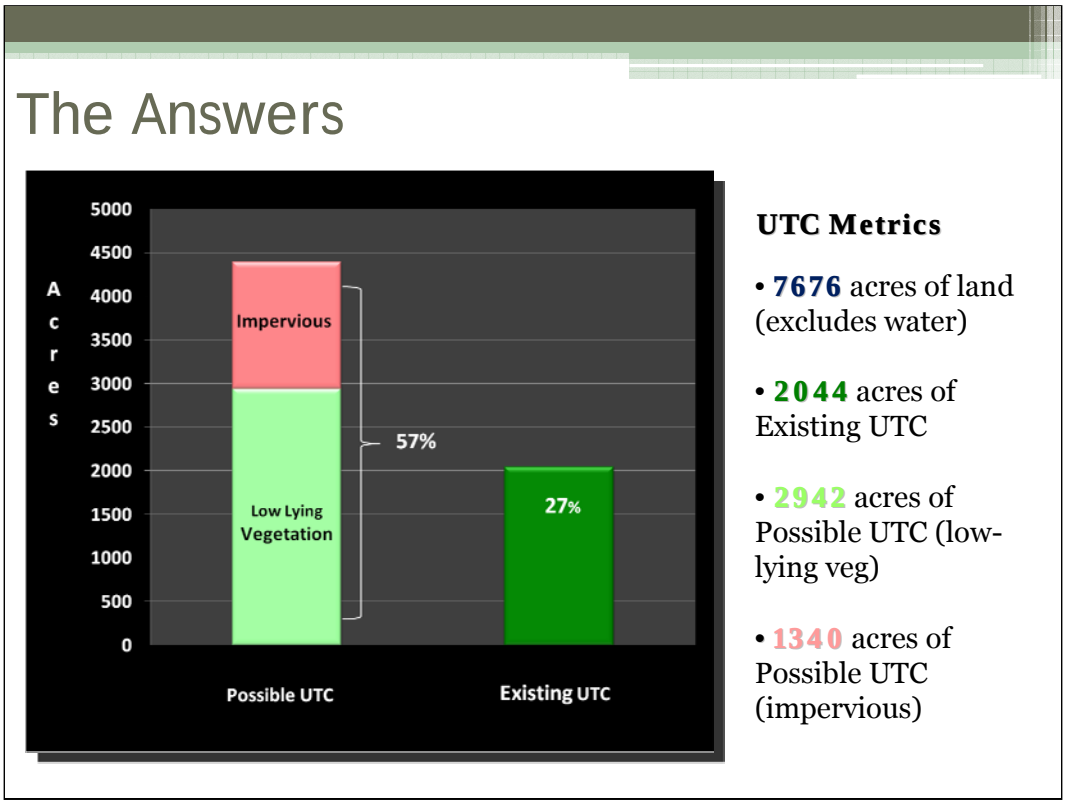
This presentation cover the UTC assessment protocols developed by the USDA Forest Service's Northern Research station in collaboration with the University of Vermont's Spatial Analysis Laboratory. The aim of the UTC assessment is to increase decision maker's understanding of their urban forest resources, particularly as it relates to the amount of tree canopy that currently exists and the amount of tree canopy that could exist. The UTC assessment protocols have been applied to ten cities, and the results of these assessments have be used to inform UTC goals, assist in targeting tree canopy efforts, and justify budget increases for urban forestry programs.

The Questions

- How much tree canopy do I have?
- How much tree canopy could I have?

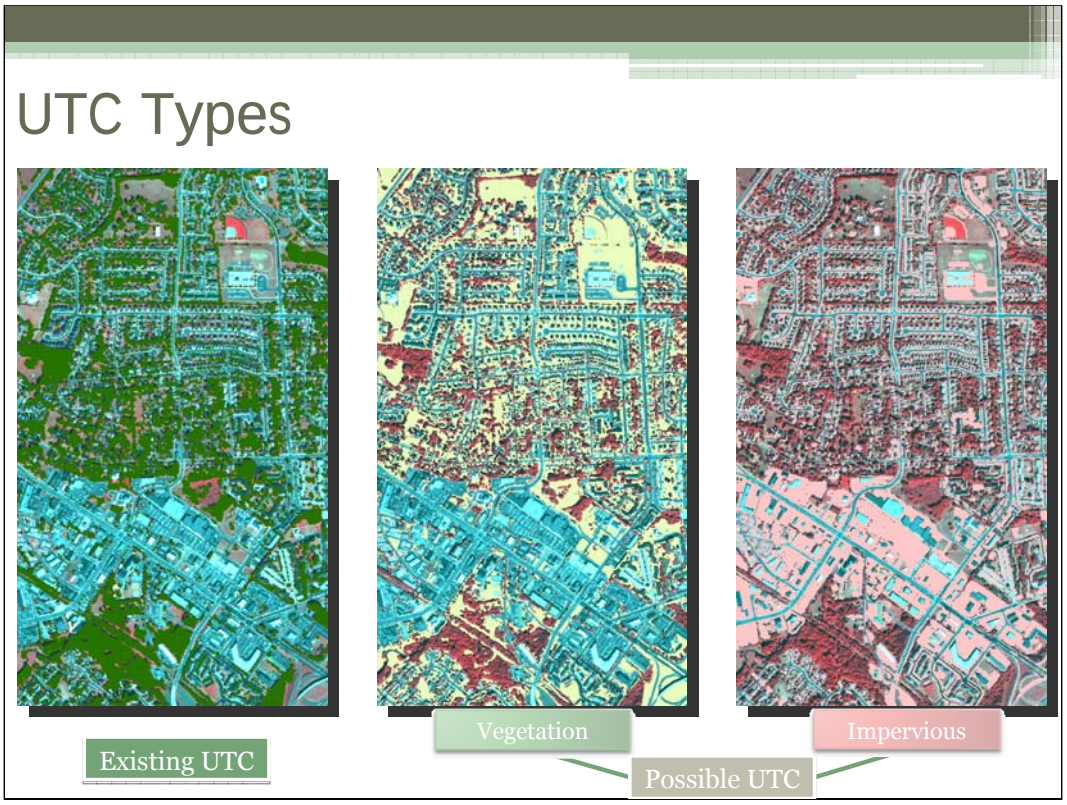
Animation instructions: N/A

The goal of the UTC assessment is to provide decision makers with detailed metrics regarding the tree canopy that exists in the urban forest. The metrics allow them to not only understand the urban forest in its current form, but to plan feasible approaches to increasing UTC. The UTC assessment was designed to answer two principal questions often posed by decision makers:
1)How much tree canopy do I have?
2)How much tree canopy could I have?



Animation instructions: N/A

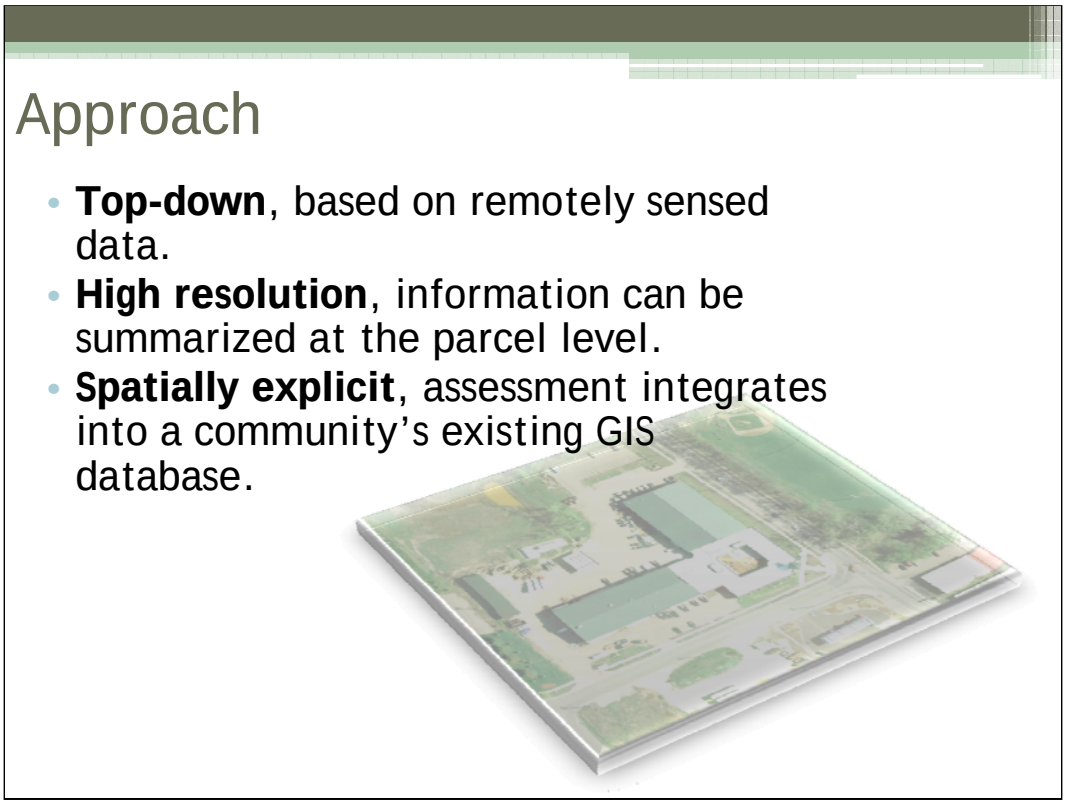
The UTC assessment provides answers in the form of UTC metrics. These metrics may be in the form of summary statistics as presented here, or they may be in the form of location specific information tied to geographical boundaries such as a city's parcel database. In the example shown here the UTC Assessment for town of Leesburg, VA indicates that Leesburg's current tree canopy, termed Existing UTC, is 27% of Leesburg's land area. The UTC assessment also showed that there is substantial land available for increasing the overall tree canopy. This land, termed Possible UTC consists of areas where it is biophysically feasible to establish tree canopy. It is important to note that it is not feasible to establish tree canopy on all the land identified as Possible UTC, not only would it require a monumental tree planting effort, but features such as lawns and playing fields are valuable when left as open space.



<u>Animation instructions</u>
1st click – Existing UTC overlay
2nd click – Possible UTC vegetation overlay
3rd click – Possible UTC impervious overlay

This shows graphically the difference between the UTC types for the town of Leesburg, VA. The imagery in the background was acquired by the Quickbird satellite, © DigitalGobe, in October 2007.

Existing UTC consists of all tree canopy
Possible UTC is divided into two types:
Vegetated Possible UTC consists of grass and shrubby areas
Impervious Possible UTC consists of non-building, non-road areas that are impervious or bare soil.



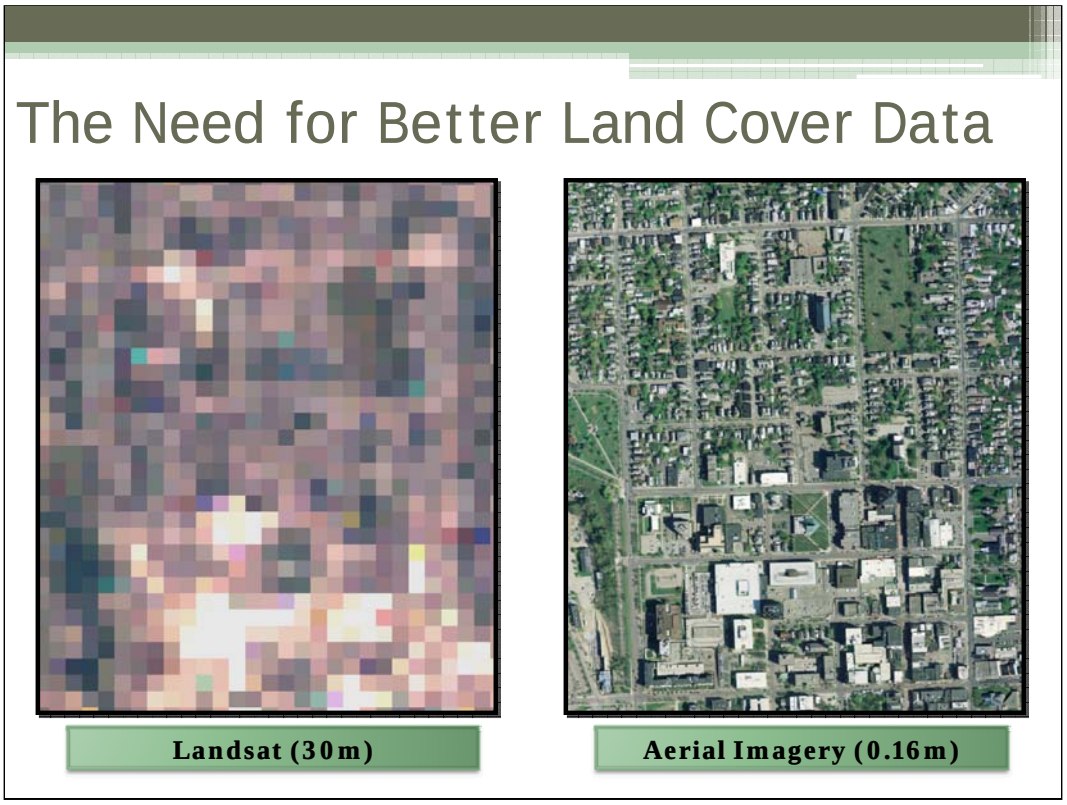
Animation instructions: N/A

The UTC Assessment is a top-down approach that is based on extracting information from high-resolution satellite imagery and integrating it with cadastral and planimetric GIS datasets. The end products of the UTC Assessment are a set of UTC metrics. There are two principal UTC metrics – Existing UTC and Possible UTC. Existing UTC is any piece of land currently covered by tree canopy when viewed from above. Possible UTC is the land where it is biophysically feasible to plant trees. Possible UTC is divided into two types – vegetation and impervious. Vegetated Possible UTC consists of grassy and shrubby areas where tree canopy could be present. A residential lawn is an example of vegetated Possible UTC. Impervious Possible UTC consists of impervious surfaces or areas of bare soil that are not roads or buildings. Tree canopy could conceivably be established on these areas by either improving the landscape or through overhanging tree canopy, but there exist substantial challenges in doing so.

Animation instructions: N/A

The UTC assessment protocols were designed to take advantage of the high resolution geospatial datasets that are the standard for most communities. During a UTC assessment high resolution land cover is integrated with planitmetric datasets, such as buildings and roads to determine the Existing UTC and Possible UTC. The UTC metrics can then be summarized using cadastral and boundary datasets consisting of rights of way (ROW), property parcels, and target geographies. Target geographies are boundary datasets such as wards, neighborhoods, census blocks, zoning districts, etc.

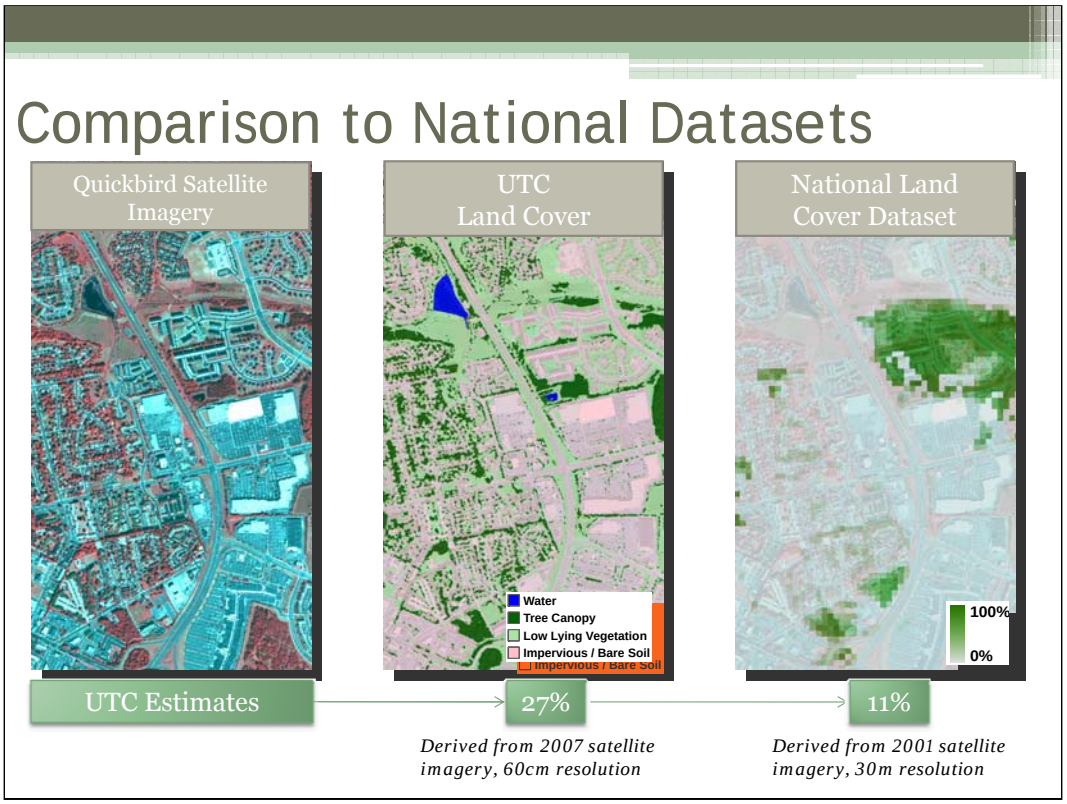
Most communities have high resolution building footprints, road polygons, parcels, public rights-of-way and target geographies (neighborhoods, census blocks, etc.) in their GIS database. Less common is the high resolution land cover that serves as the basis for most of the UTC assessment. Manual interpretation of remotely sensed data is too timely and costly. Fortunately advances in automated feature extraction make deriving land cover information from high resolution remotely sensed datasets cost effective.



Animation instructions:
1st click: highlights area, and zooms in.

Land cover data exists for the entire United States in the form of the National Land Cover Dataset (NLCD) produced by the USGS. NLCD is a powerful dataset, but because it is derived from 30m resolution Landsat satellite imagery it is not suitable for mapping the urban forest. The high heterogeneity of urban areas requires that land cover be derived from higher resolution remotely sensed datasets, such as that acquired from aerial imagery and satellite sensors.

This example graphically shows how 30m Landsat imagery, which is used as the basis for NLCD, fails to capture the detail of the urban forest.



Animation instructions: N/A

This slide compares the results of estimating tree canopy for Leesburg using two sources: the high resolution UTC land cover layer created as part of the UTC Assessment, and the USGS National Land Cover Dataset (NLCD) tree canopy layer. The UTC land cover layer was derived from 60cm resolution Quickbird satellite imagery acquired in October 2007. Land cover was mapped into four discrete categories: tree canopy, low-lying vegetation, impervious, and water. The NLCD layer was derived from circa 2001 30m resolution satellite imagery and each 30m pixel was assigned a value of 0-100 based on the percent tree canopy in each pixel. As is evident here, in heterogeneous urban areas where tree canopy is relatively small and fragmented datasets such as NLCD grossly underestimate tree canopy in urban areas. Problems also arise due to the dated nature of NLCD. The large patch of forest in the upper right is now a residential subdivision. Furthermore, the resolution of NLCD prevents the information from being summarized at the parcel level.

Feature Extraction

Image Segmentation

↓

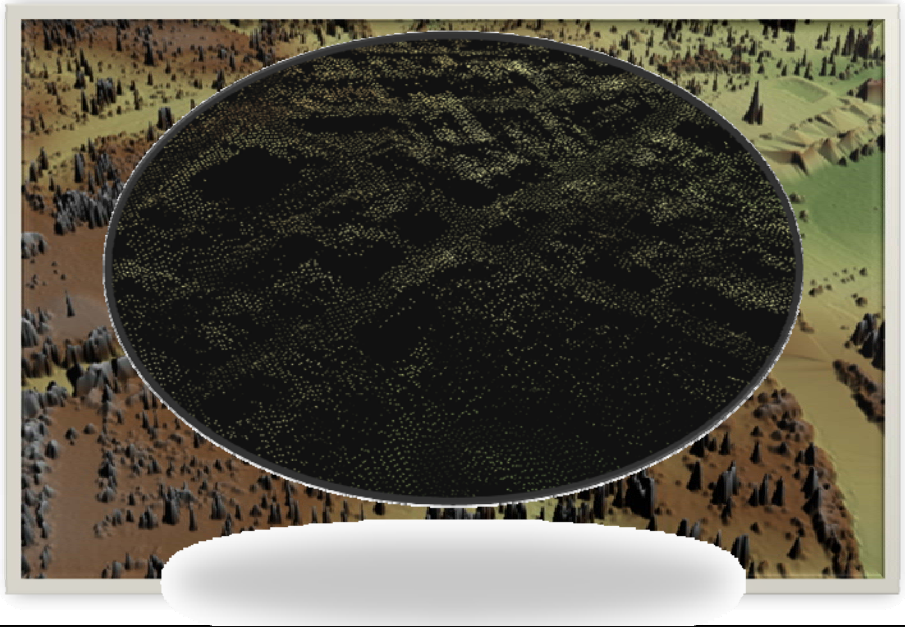
Rule Development

↓

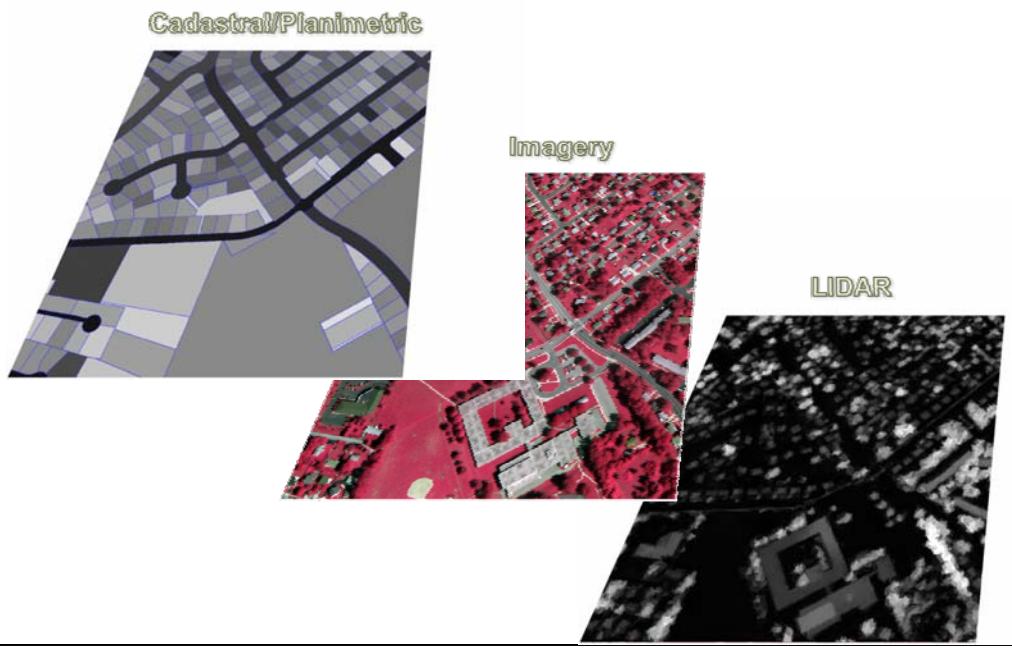
Derive Land Cover

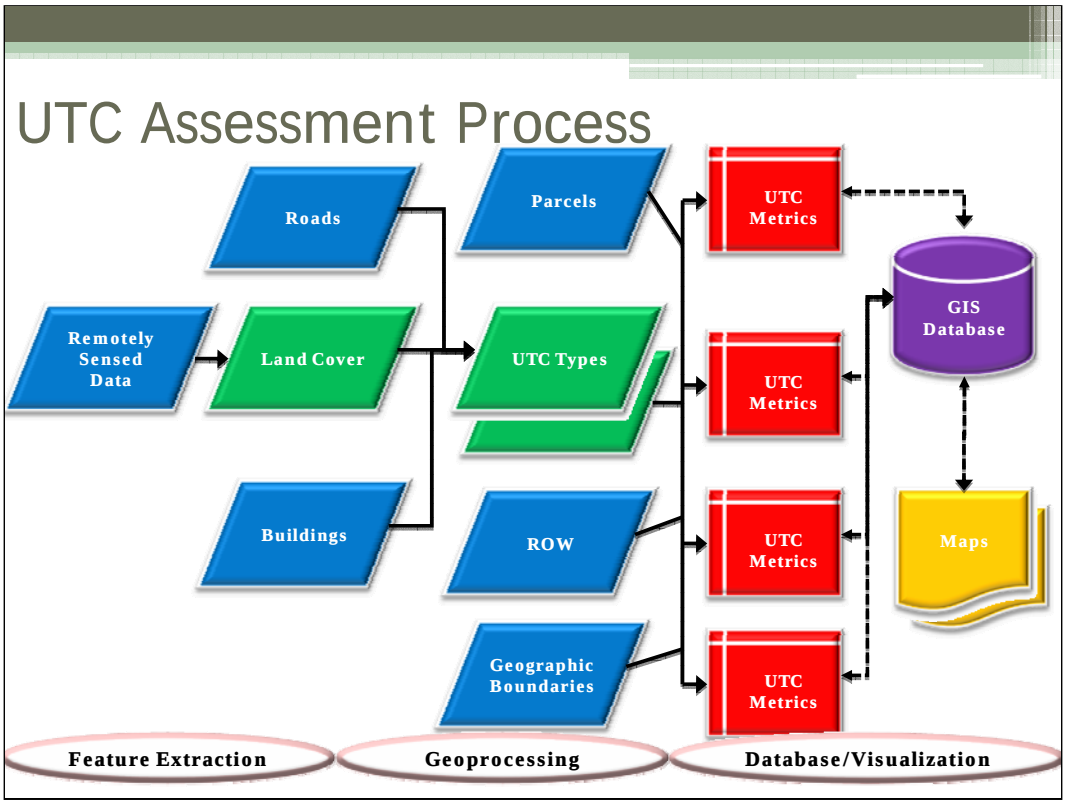
NAIP

LIDAR



Sensor Data

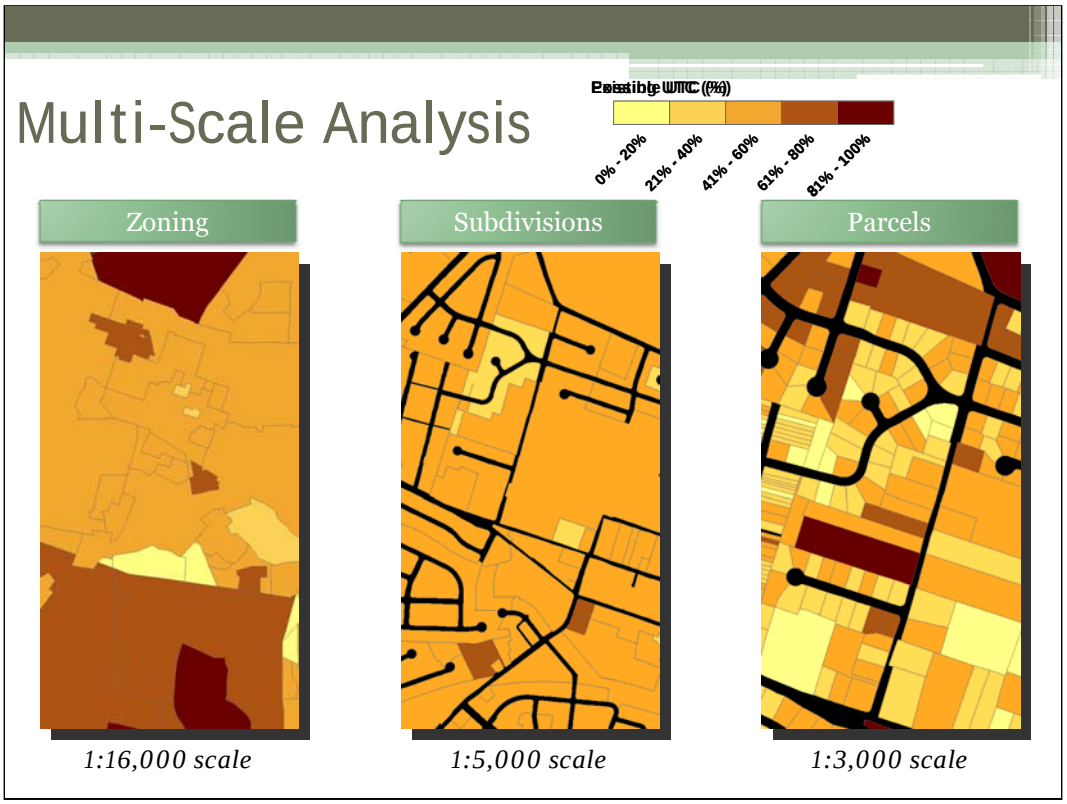




Animation instructions: N/A
1st click: feature extraction
2nd click: geoprocessing
3rd click: database linkages and map products

The UTC assessment process can be generalized into three steps: 1) feature extraction, 2) geoprocessing, and 3) database linkages and visualization.

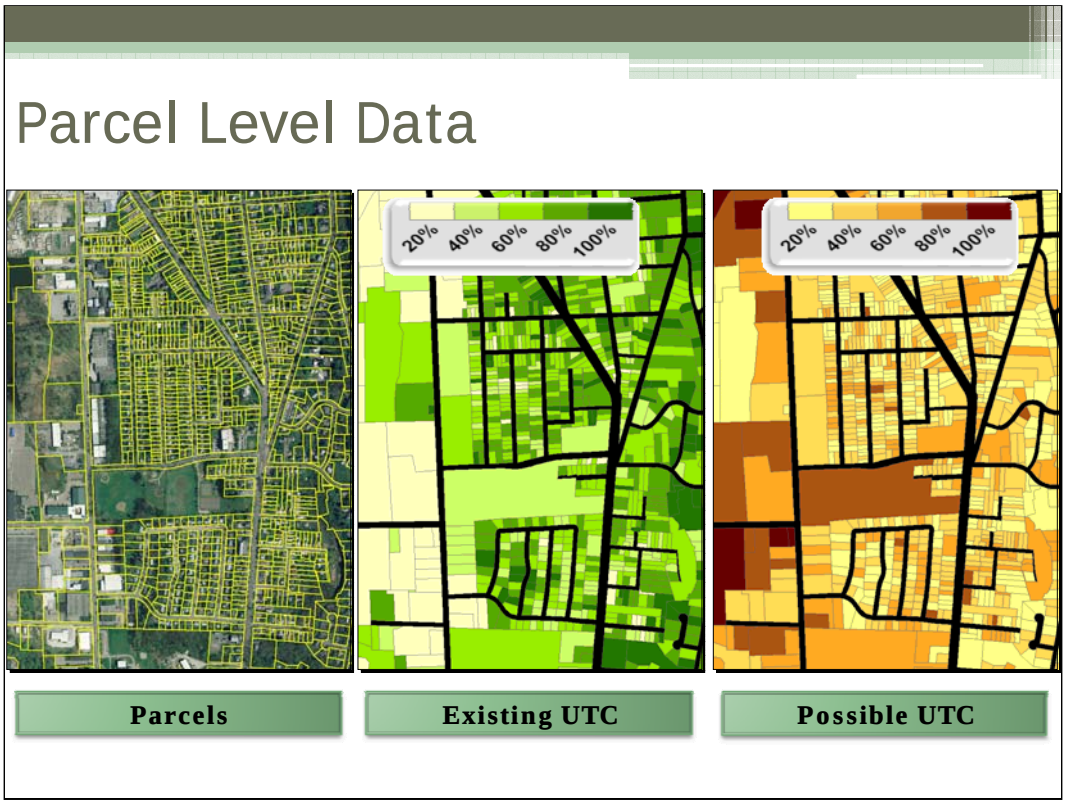
Demonstrated in previous slides, the first phase involves the extraction of land cover information from remotely sensed datasets such as imagery and LIDAR. The second phase involves synthesizing the land cover data with the planimetric data, buildings and roads, to derive the UTC types – Existing UTC and Possible UTC. The UTC types are then summarized using cadastral datasets and geographical boundaries. The result is a series of UTC metrics. Metrics are generated for the ROW, parcels, and geographical boundaries. In the final step the UTC metrics are linked to the GIS database to generate summary statistics and produced cartographic products.



<u>Animation instructions</u>:

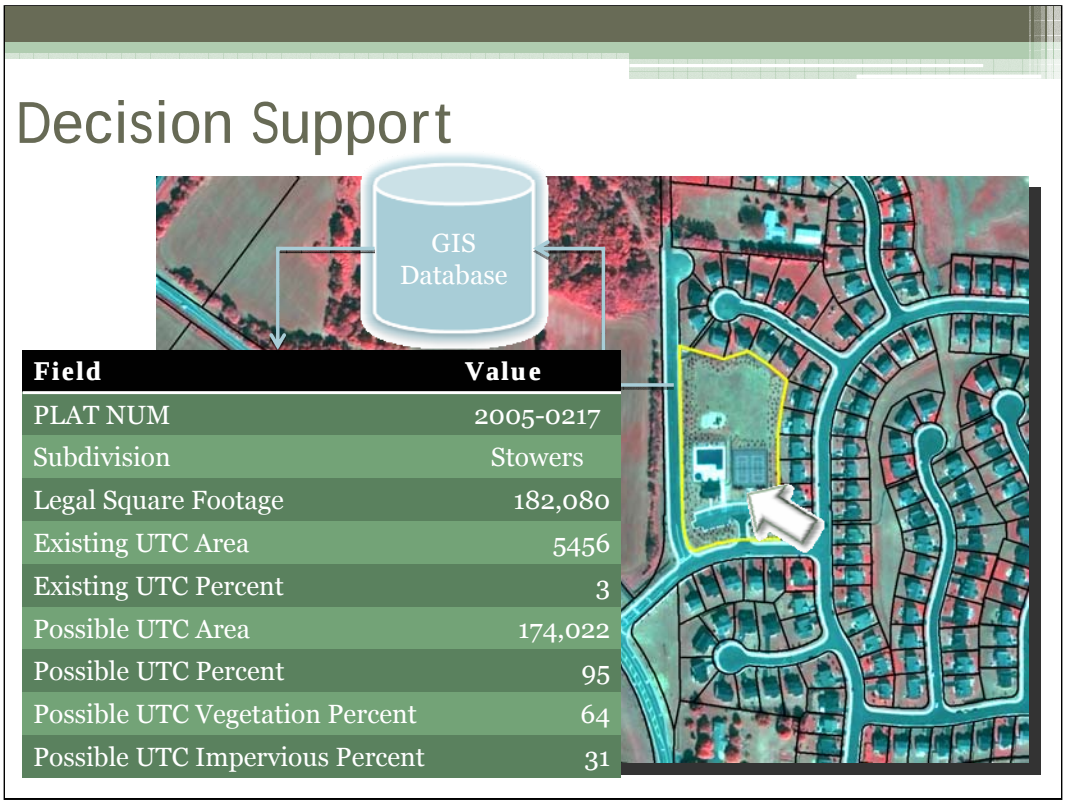
1st click – polygons
2nd click – Existing UTC
3rd click – Possible UTC

UTC metrics can be summarized using cadastral and boundary datasets to yield scale appropriate for further analysis. This example from Leesburg, VA shows, for three distinct areas, how UTC metrics are summarized using zoning, subdivisions, and parcels.



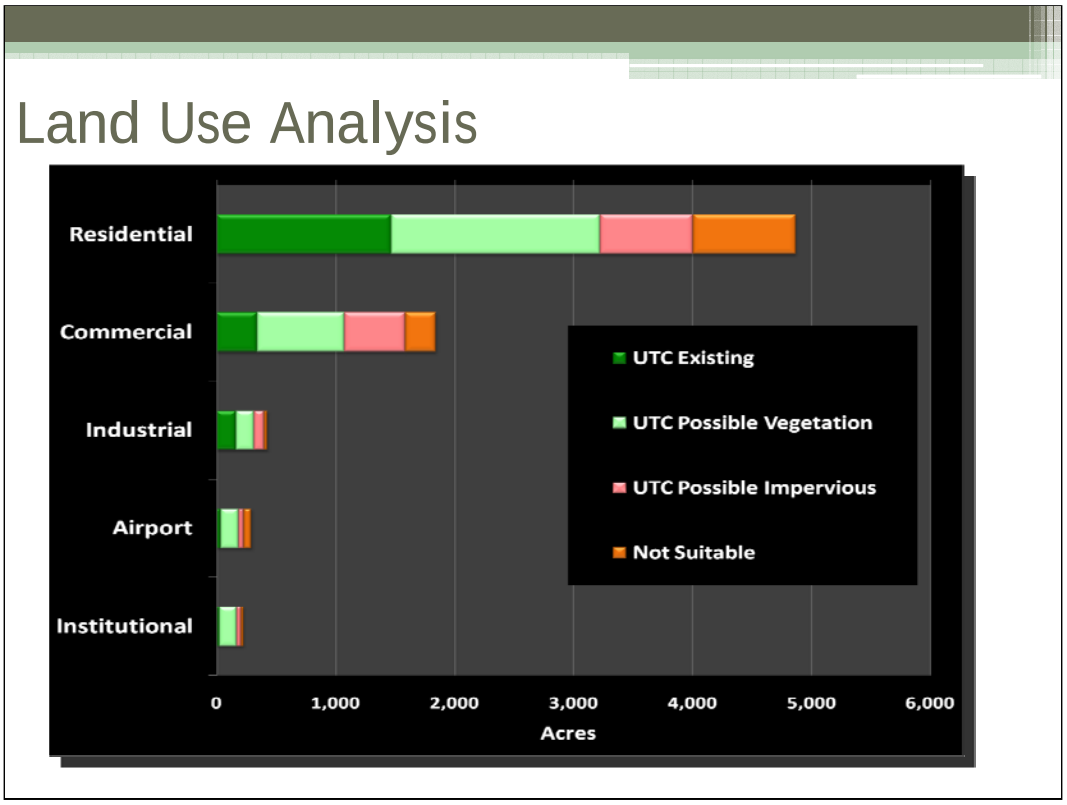
Animation instructions: N/A

As management regimes and policy decisions most often occur at the parcel level, parcel-based UTC metrics are perhaps the most useful outcome of the UTC assessment. The utility of these UTC metrics relies heavily on both accurate land cover and parcel boundaries.



Animation instructions:
1st click – decision support animation

Because the UTC metrics are tied to the city's parcel database decision makers can use GIS to find out the specific UTC metrics for a parcel or set of parcels. This information can be used to estimate the amount of tree loss in a planned development or set UTC improvement goals for.



Animation instructions: N/A

As UTC metrics are tied to a community's existing GIS database, the results of the UTC assessment can be summarized using meaningful attributes such as land use. In this example from Leesburg, VA, UTC metrics are generated by on zoning. The vast majority of Leesburg's Existing UTC and Possible UTC is in zoning districts dominated by residential land use. As a result it is Leesburg's residents who hold he key with respect to preserving Leesburg's current UTC and increasing Leesburg's tree canopy in the future.

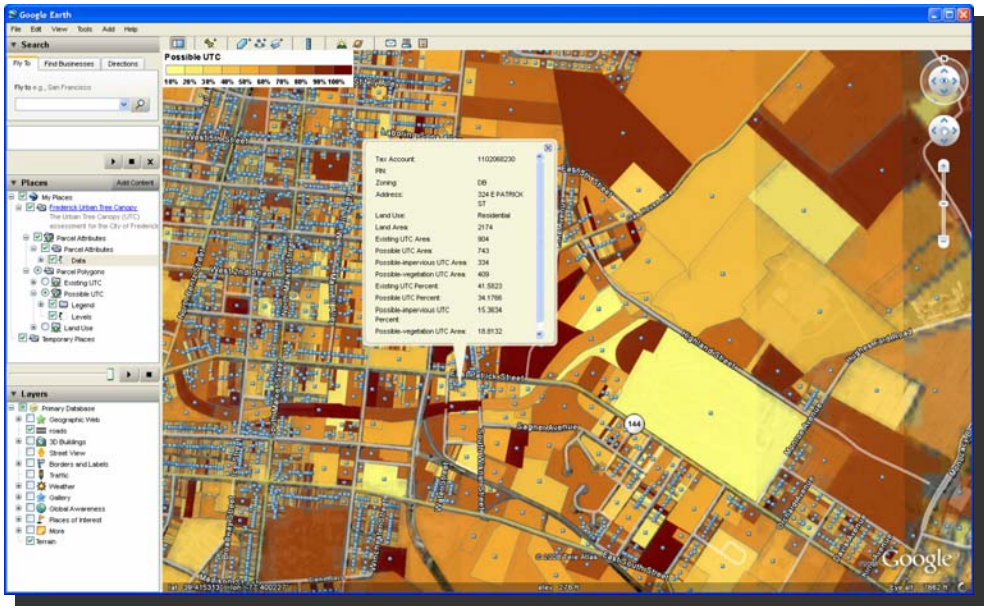
UTC Goal Setting

LandUse	Existing UTC	Possible UTC	Improvement (% of Possible)	UTC Current	UTC Goal (%)
Residential	19%	33%	20%	26.6%	31.9%
Commercial	4%	16%	10%		
Industrial	2%	3%	5%		
Airport	0%	3%	0%		
Institutional	0%	2%	20%		

Animation instructions:
1st click – shows the results of using the UTC calculator UTC for goal setting

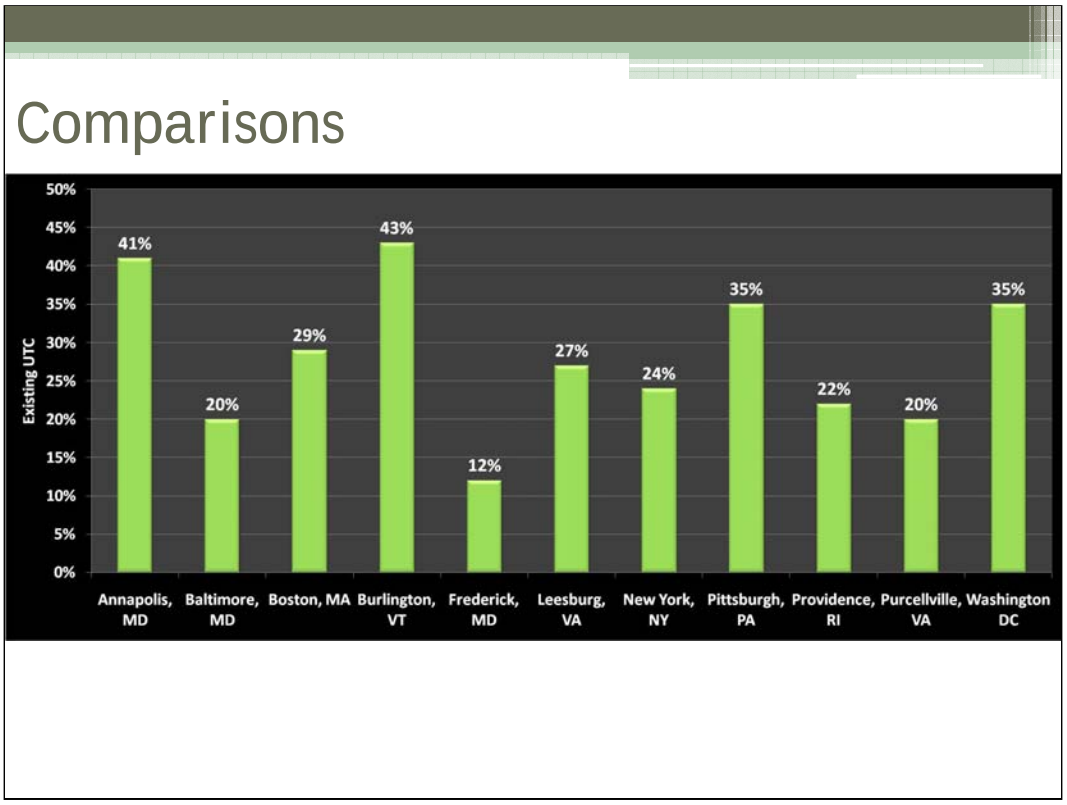
As has been mentioned it is not feasible to establish tree canopy on all areas classified as Possible UTC. To assist in determining a UTC goal the UTC assessment process includes the development of a UTC calculator. The UTC calculator allows the end user to examine the effect that improvements to UTC in specific land use categories have on the end UTC goal. In this example the desired amount of Possible UTC to be improved in both the residential and institutional categories is increased. If these improvements could be realized on the ground the Existing UTC in Leesburg could increase to nearly 36%. Note that it is not feasible to establish any significant amount of tree canopy on the airport so the improvement is left at 0%.

Visualization & Outreach



<u>Animation instructions</u>: N/A

With the advent of technologies such as Google Earth and Google Maps the general public is much more spatially aware. This technology can be harnessed by the UTC assessment to improve outreach. For the UTC assessment for Frederick, MD the data was made available via Google Earth. This allowed end users to view the Existing UTC and Possible UTC for all parcels in Frederick while at the same time having access to all of Google Earth's other functionality.



Animation instructions: N/A

As the number of cities that have completed UTC assessment continues to grow, meaningful comparisons can be made as to the state of tree canopy in our urban forests. This comparison also helps to stoke healthy competition between cities as being labeled "green" is a highly valued marketing technique.

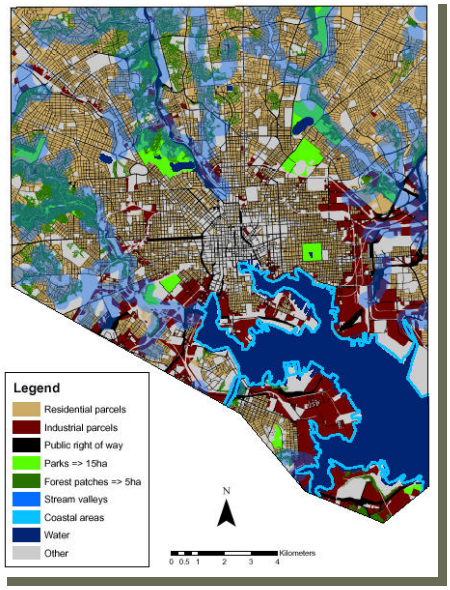
What's Next?

1. **Possible:** what is ecologically feasible?
   - Where is land available for tree planting?
2. **Potential:** what is economically likely?
   - Which areas have regulatory constraints that conserve tree cover or have incentive supports for adding tree cover?
   - Which areas are more cost-effective for achieving water quality goals?
3. **Preferable:** what is socially desirable?
   - Where will tree cover make neighborhoods more attractive?
   - Where will tree cover address other social issues such as cooling and cleaning the air?

The UTC assessment protocols are constantly evolving. Future efforts aim to help improve UTC site selection by helping decision makers answer not only what is possible, but what is potential and preferable when it comes to increasing urban tree canopy.

Spatial Analysis - FOS

	Coastal	Stream Valleys	Forest Parcels	Parks	Industrial Parcels	Residential Parcels	PROW
Coastal	1046	68	11	2	184	3	29
Stream Valley		15692	3251	1793	1372	4411	2637
Forest Patches			4553	1131	179	1349	359
Parks				2845	0	0	0
Industrial Parcels					6227	0	1
Residential Parcels						16087	0
PROW							10971



<u>Animation instructions</u>: N/A

The Forest Opportunity Spectrum (FOS) is another example of how data from the UTC assessment can be analyzed spatially to help determine opportunities for increasing urban tree canopy. In this example from Baltimore overlaps in key areas targeted for improving UTC are examined to determine where resources can be best directed to achieve multiple objectives.

Spatial Analysis

- Scenario #1
  - > 20% Contiguous Forest
  - < 25% Impervious
  - > 50% Vegetation
  - < 50% Border with Roads
- Scenario #2
  - <25% Buildings
  - > 50% Impervious
  - <10% Trees

<u>Animation instructions</u>:
1st click: Analysis #1
2nd click: Analysis #2

Spatial analysis can be used to assist, as in this example from Burlington, VT, in targeting parcels for conservation (Scenario #1) or improvement (Scenario #2).