

The Effect of Land Use on Atmospheric Carbon Dioxide (CO₂)

Joseph D. Hee, Gulnihal Ozbay

Department of Agriculture & Natural Resources, Delaware State University, Dover, DE-19901

Introduction

CO₂

- Colorless, odorless, gas.
- Primary contributor to the Greenhouse Effect, which is the driving force behind Global Warming and Climate Change
- Opaque to some wavelengths of Infrared light (IR) which causes it to absorb some of the energy that is emitted from Earth's surface, trapping it close to the planet and raising the temperature.
- Released through the combustion of fossil fuels and biomass, both major drivers of human activity.

Land Use

- No separate definition from land cover under the USDA who defines it as: *"The purpose of human activity on the land; it is usually, but not always, related to land cover."*
- As a measure of human activity in an area and as a consequence the potential for CO₂ release.
- Directly under the control of counties and municipalities through the use of zoning regulation while otherwise being driven by the local resources present in an area.

Materials and Methods

Measurement

- Measurements were taken using a Testo 535 hand-held CO₂ Meter.
- Testo 535 measures CO₂ using IR light the gauge the absorbance by the air.
- Experimenter moved away from all active sources of CO₂ during start up sequence and measurement, measuring and recording the maximum, minimum, and average PPM of CO₂ over a 5 minute period.
- Measurement was tied to two important periods: Sunrise and sunset. This was because they both represent the periods when photosynthesis becomes active and inactive which is a major point when CO₂ is absorbed versus released.

Mapping

- Sites were evaluated for their prevailing land use using the National Land Cover Database and compared against imagery from the National Agricultural Imagery Program.

Site Description

Site 1 (Fig 1.1)

Location: Suburban Newark, DE

This area was chosen because it represented a tight divide between a urbanized area and a forested zone.

Site 2 (Fig 1.2)

Location: Christiana Mall Park and Ride

This site was chosen as an example of an extremely urbanized area, almost all the area around it is paved or a commercial structure. The USGS map is slightly out of date and the area includes new construction.

Site 3 (Fig 1.3)

Location: Silver Lake Dam, Dover, DE

This site was chosen to explore how a body of water might have an effect on the results.

Site 4 (Fig 1.4)

Location: White Clay Creek Woodland

This site is heavily wooded and was chosen for that reason.

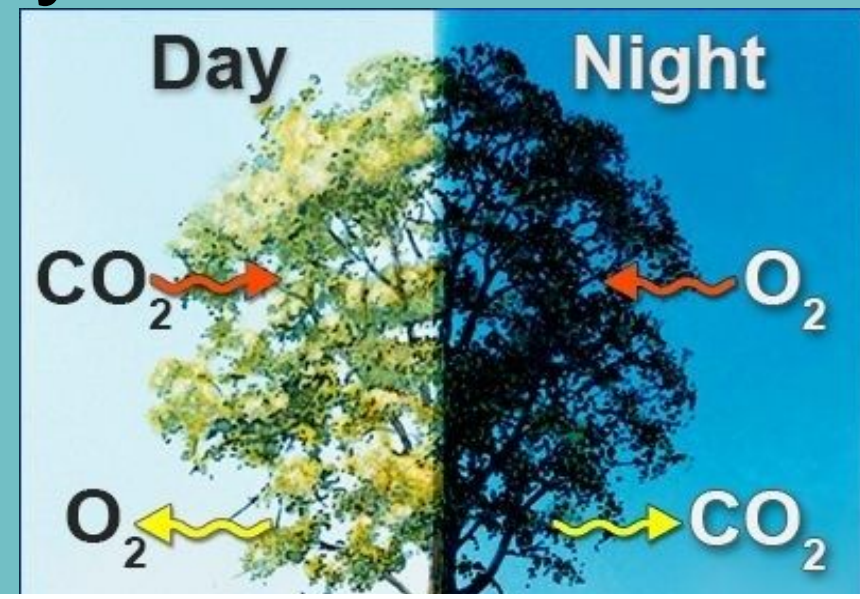
Site 5 (Fig 1.5)

Location: U of D agriculture Complex

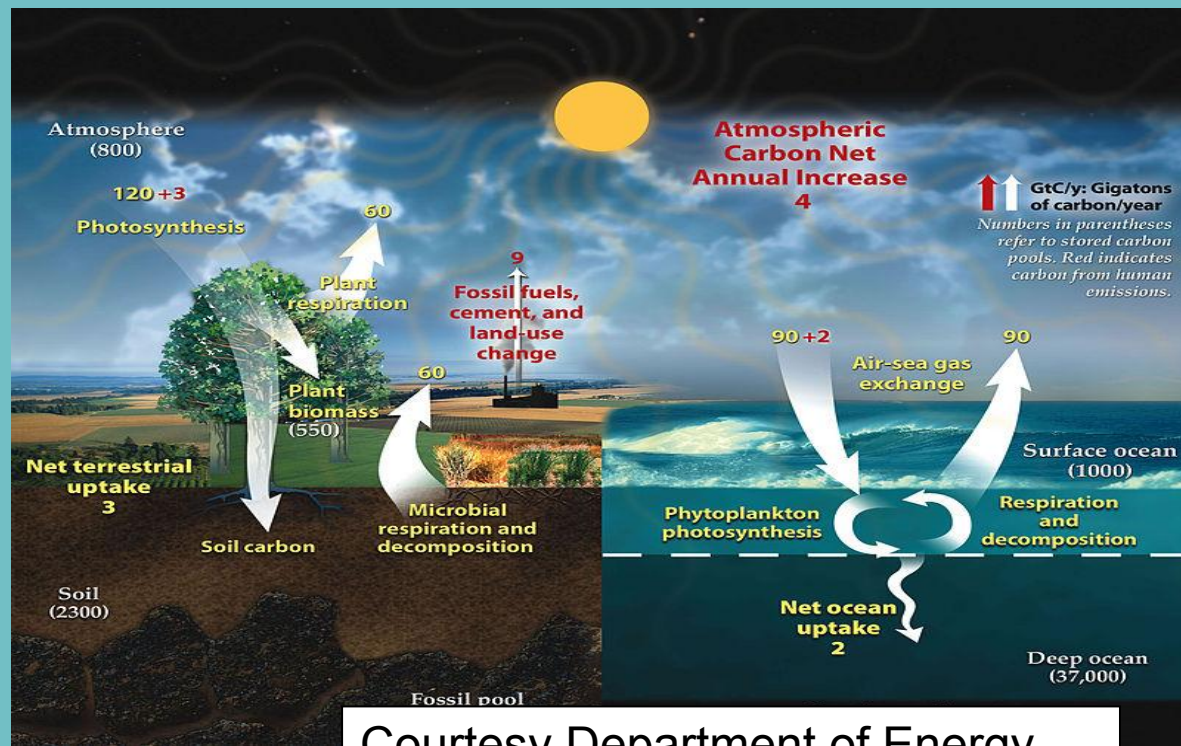
This site was chosen to represent an agricultural complex. Some of the area listed on the map as cleared land is actively cropped at the time measurements were taken.

Results

Site Name	Site 1	Site 2	Site 3	Site 4	Site 5
Morning min.(ppm)	554	491	409	332	501
Morning max.(ppm)	589	632	587	775	626
Morning avg.(ppm)	557	508	426	501	554
Evening min.(ppm)	358	641	426	377	376
Evening max.(ppm)	414	684	539	497	499
Evening avg.(ppm)	364	642	426	422	379



<https://www.quora.com/Plants-produce-carbon-dioxide-as-a-product-of-cellular-respiration-but-they-release-oxygen-rather-than-carbon-dioxide-How-is-this-possible>



Courtesy Department of Energy

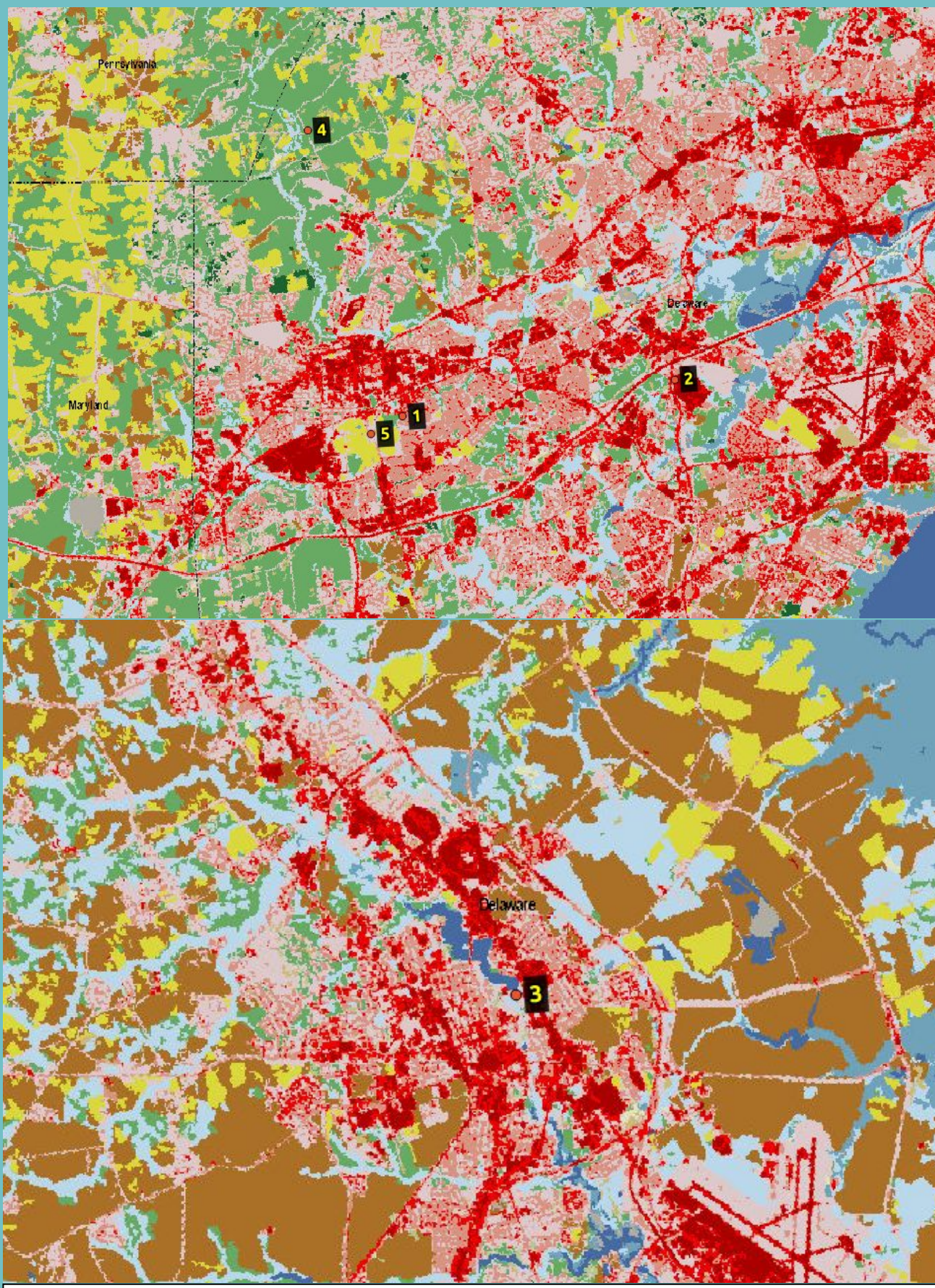


Fig. 2.1: Sites 1, 2, 4, and 5 in relation to another.(Top)

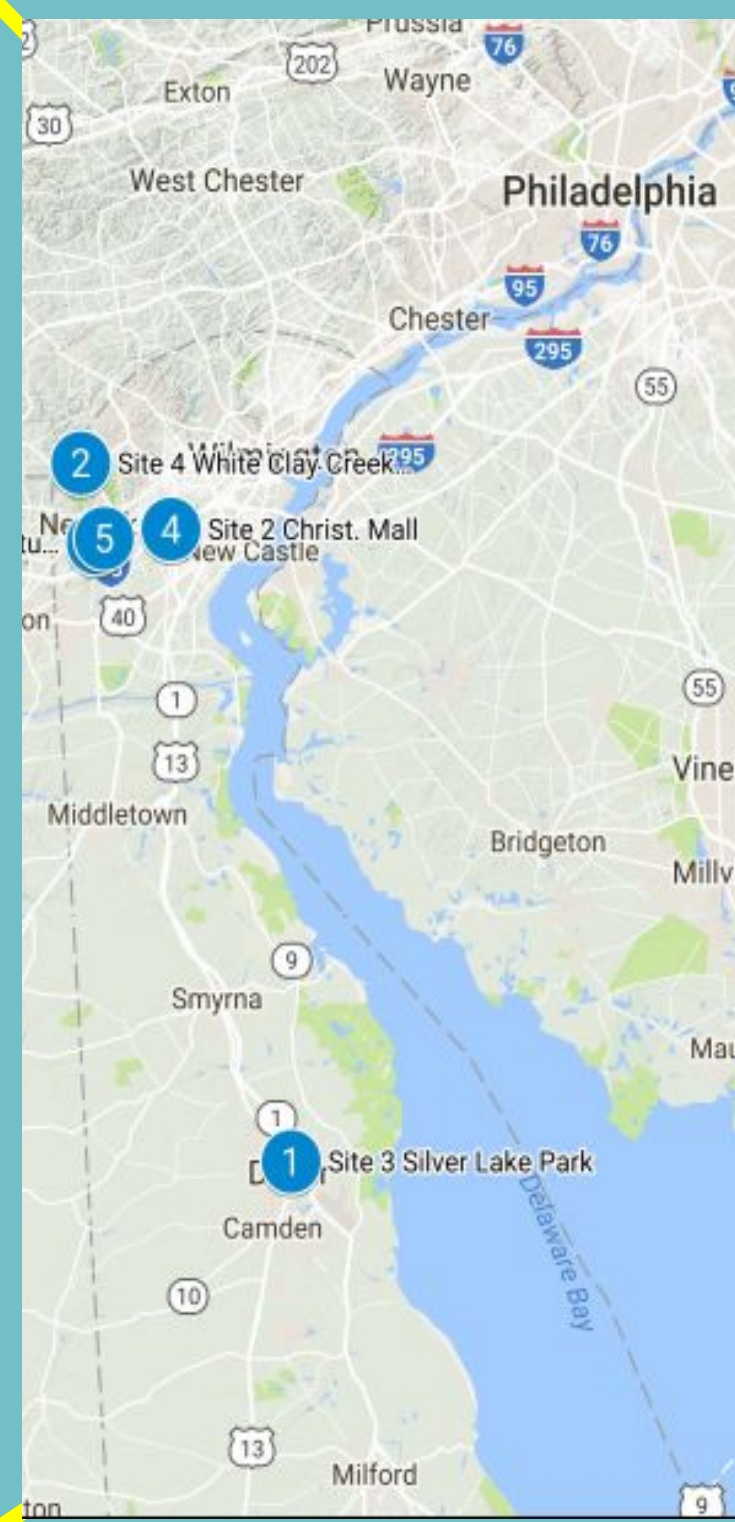


Fig. 2.2: Site 3 pictured with surrounding area. (Bottom)
Fig 2.3 All sites mapped, courtesy of google maps (Right)

Discussion

Areas with higher concentrations of vegetation had more pronounced differences in atmospheric CO₂ throughout the day compared with more urbanized areas:

- Vegetated areas seemed to have the CO₂ levels decrease as the day went on while urbanized areas had other influences, likely due to the increased presence of photosynthesis processes in vegetated areas and how they were tied to sunlight.
- Vegetated areas also had a wider 'swing' in CO₂ counts throughout the day, starting at a point higher than the average for the urbanized areas they were compared with but dropping far below that by the end of the day. This can be attributed to increased 'load' put on the local atmosphere overnight as trees continue to respire while urbanized areas see decreased human activity.

Conclusion

The data presented in this experiment were at best preliminary to future experiments. Difficulty in obtaining data was frequent and future experiments in this area would be better served by using a system that automatically logged data over a period due to potential limits to a experimenters access to area, transportation, the ambient weather, and scheduling which all interferes with measurements at the critical points of time. With all that in mind there remains an apparent correlation between land use and CO₂ levels in the atmosphere.

Acknowledgements

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References

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

Maps provided by the USGS and Google Maps, created using QGIS



Fig 1.1
Suburban Newark

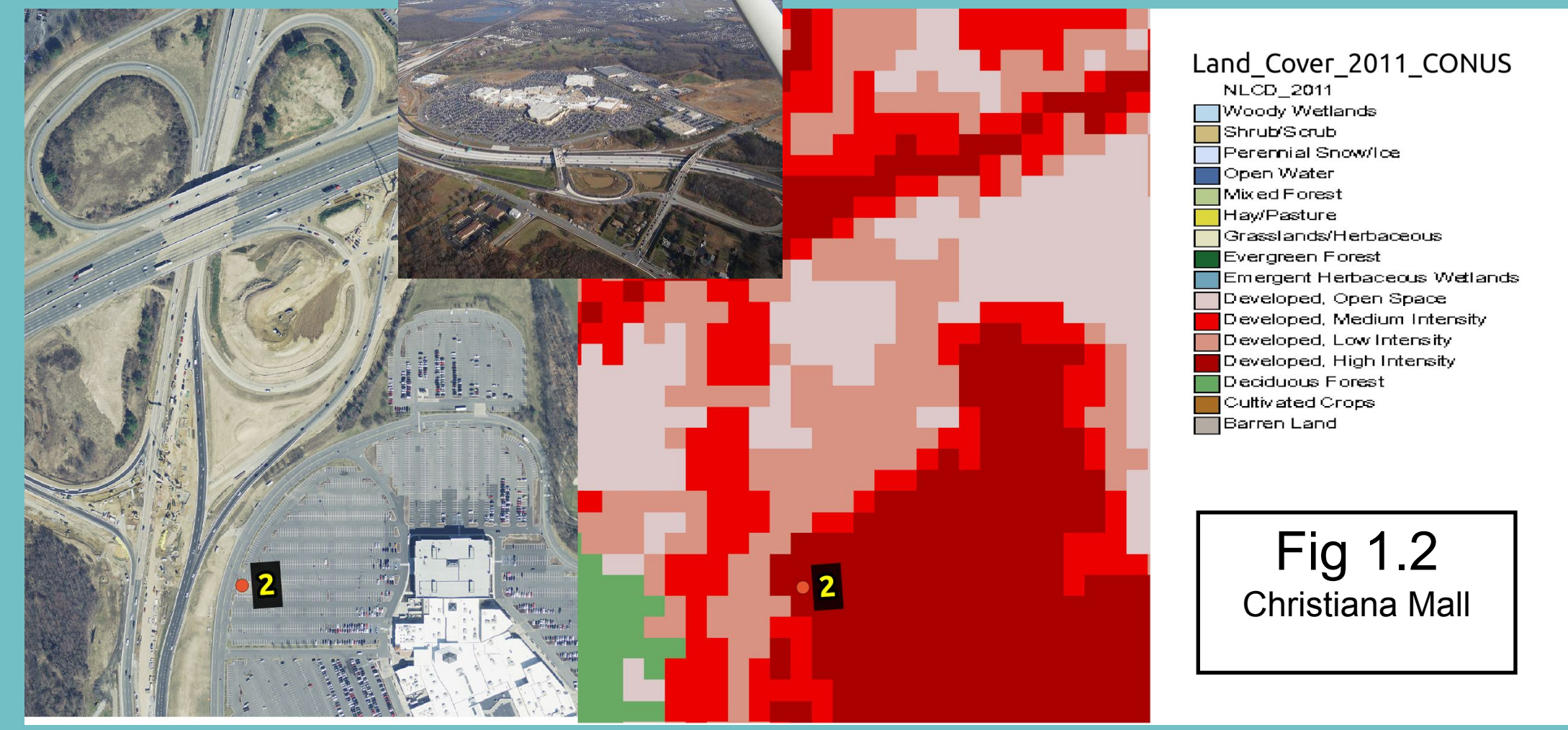


Fig 1.2
Christiana Mall

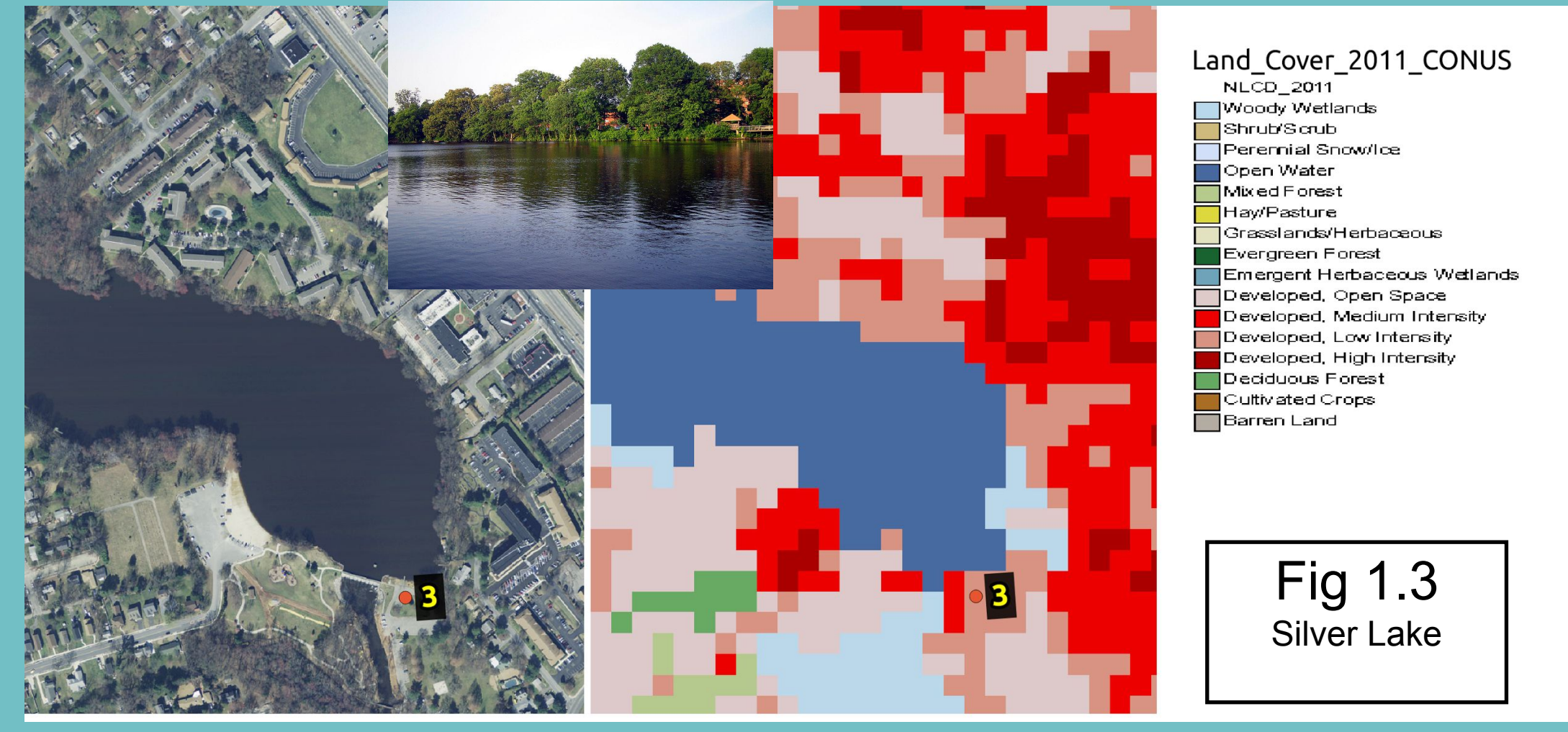


Fig 1.3
Silver Lake

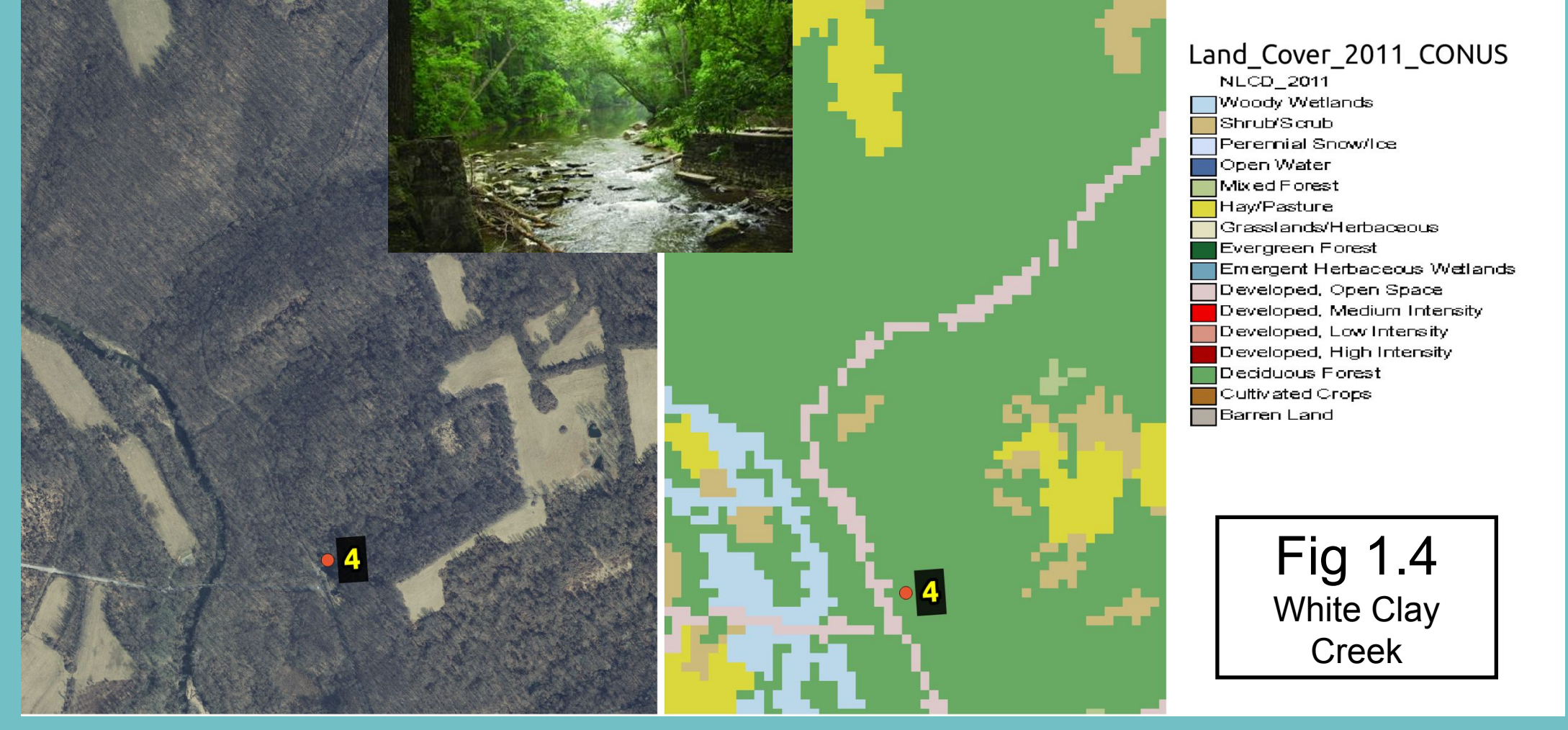


Fig 1.4
White Clay Creek



Fig 1.5
Farm Lane