# Spatial Analysis of Scattered Tree Loss in Livingston County, New York, 1938 to 2021

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## Introduction

This study examines the extent and causes of scattered tree landscape loss in Livingston County and the Town of Geneseo, New York between 1938 and 2021. Scattered tree landscapes possess ecological, cultural, and aesthetic value (Kuyah et al.,2016). Known as "wood pastures" in the United Kingdom, "parkland" in Australia, and "dehesas" in Portugal and Spain (Manning et al., 2009), scattered tree landscapes containing mature trees outside of forests (FRA 2000, 2000) are common to savanna vegetation communities (Ritter, 2022). Scattered trees are an ecological and cultural "keystone structure" in many landscapes around the world, serving as habitat and a source of food and materials. They may also enhance landscape connectivity and act as nuclei for habitat regeneration in disturbed landscapes (Prevedello et al., 2017).

Beginning in the 20th century, however, scattered tree landscapes have decreased in extent worldwide as a result of numerous land-use processes, including agricultural land conversion (Foley et al, 2005). This study investigates scattered tree landscape loss in Livingston County, New York, which includes the Town of Geneseo (Figure 1). Encompassing the middle Genesee Valley, Livingston County is a productive farming region containing prime agricultural soils. It is dominated by corn and soybean production and dairying. It also contains extensive areas of relict oak savanna linked to former Onöndowa'ga:' (Seneca) settlement and fire use (Tulowiecki et al., 2019). Many of these areas today contain scattered tree landscapes with aged, open-grown oaks (Figure 2) that are among the largest and oldest trees in New York State (Weidemann 1983).

Although scattered tree and relict savanna landscapes are receiving increasing scholarly (Prevadello, 2017) and popular attention (Rosen, 2022), few studies have quantified scattered tree loss and its causes over an extensive time period and spatial extent. Neither has such work been conducted, as this study is, in an area of both intensive agricultural production and relict oak savanna containing landmark trees of notable ecological and cultural value.


Figure 2: Representative scattered tree landscapes occupying relict oak savanna in the Town of Geneseo, New York.

## Data and Methods

Two scales are used for examination in this study, Livingston County and the Town of Geneseo. 1938 aerial photos of Livingston County were sourced from the Livingston County GIS Department. The photos were brought into ArcGIS Pro v.3.0 and georeferenced to 2021 aerial photos sourced from Google Maps. Livingston County was divided into 1 HA (100 m²) land units. One unit per 1 km² area was randomly selected for classification at the county scale. This systematic unaligned sampling approach allowed for classified units to be distributed across the county while avoiding issues of spatial periodicity. 1600 cells were chosen for classification. The Town of Geneseo was also divided into 1 HA land units. 2019 aerial photos were sourced from Google Maps for the Town of Geneseo analysis. All land units were classified using the following land classification system (Figure 3).

| Scattered Tree | • Majority of trees must have identifiable individual crowns and/or shadows<br>• Crowns and/or shadows may be in contact but the majority must be individually identifiable<br>• Majority of trees must be of sufficient size to be visibly identifiable as trees (they cast an identifiable shadow or branch structure is evident) |
|---|---|
| Forest | • Densely treed land unit that cannot be classified as scattered tree |
| Developed Land | • Obvious signs of residential, commercial, industrial development and transportation |
| Water | • Determined via USGS topo map |
| Other Open/Agricultural Land | • crop land and other agricultural land and related open space<br>• All land that is not identifiable as other classes |

Figure 3: Land classification system.

Each land unit was designated into one of the five land cover categories. It is important to note that trees arranged in a linear fashion (eg. along property boundaries or roads) were not classified as scattered tree land units as they were considered features of developed land. All land units were manually classified by the highest percentage of land cover within a cell using visual estimation. If percent land cover appeared to be approximately equal between two categories, the predominant land cover of adjacent cells was assigned. For the purpose of determining land cover within a cell, the open space within a scattered tree area was considered to be part of the scattered tree landscape. Landscapes and maintained spaces adjacent to developed areas were considered developed land cover. For example, if large individual trees were located in a residential yard, they were considered developed land units not scattered tree land units.

The Town of Geneseo was selected for total land area analysis (rather than sample-based analysis) due to the high percentage of relict oak savanna and scattered tree landscapes within its boundaries. The sample-based county analysis was conducted to determine if scattered tree loss and other land use trends observed in the Town of Geneseo were consistent or indicative of broader trends.

Following land unit classification, town and county data were spatially and statistically analyzed. Data was collected in ArcGIS, moved into a CSV for analysis, and land cover trends were visualized as Sankey diagrams using Sankeymatic, an open-source online resource. Town of Geneseo results were mapped in QGIS. County results were not mapped because the systematic unaligned sampling approach minimized its utility.
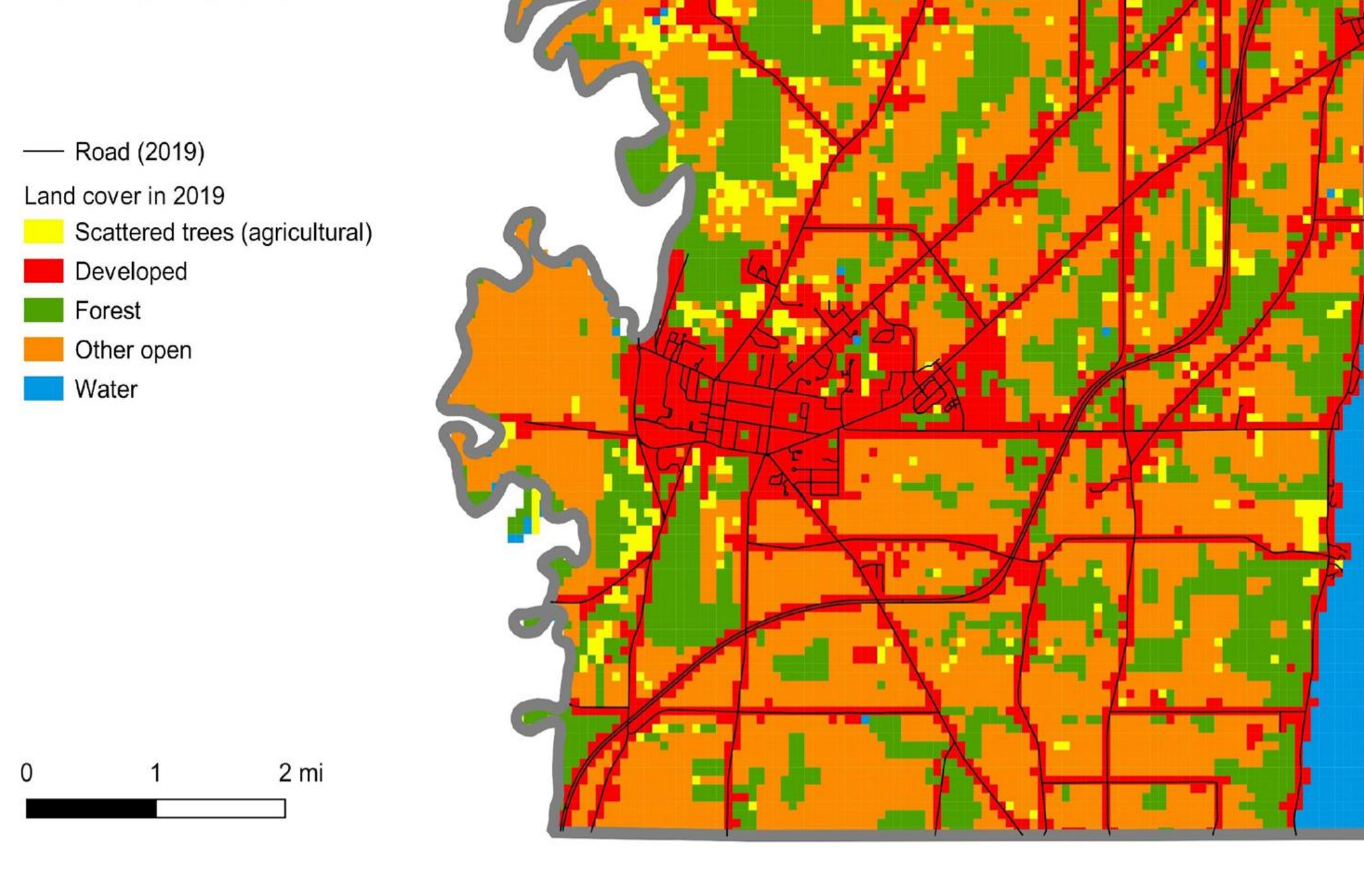
## Land cover in 1938
Town of Geneseo, New York State



Road (2019)
Land cover in 1938
Scattered trees (agricultural)
Developed
Forest
Other open
Water

0 1 2 mi
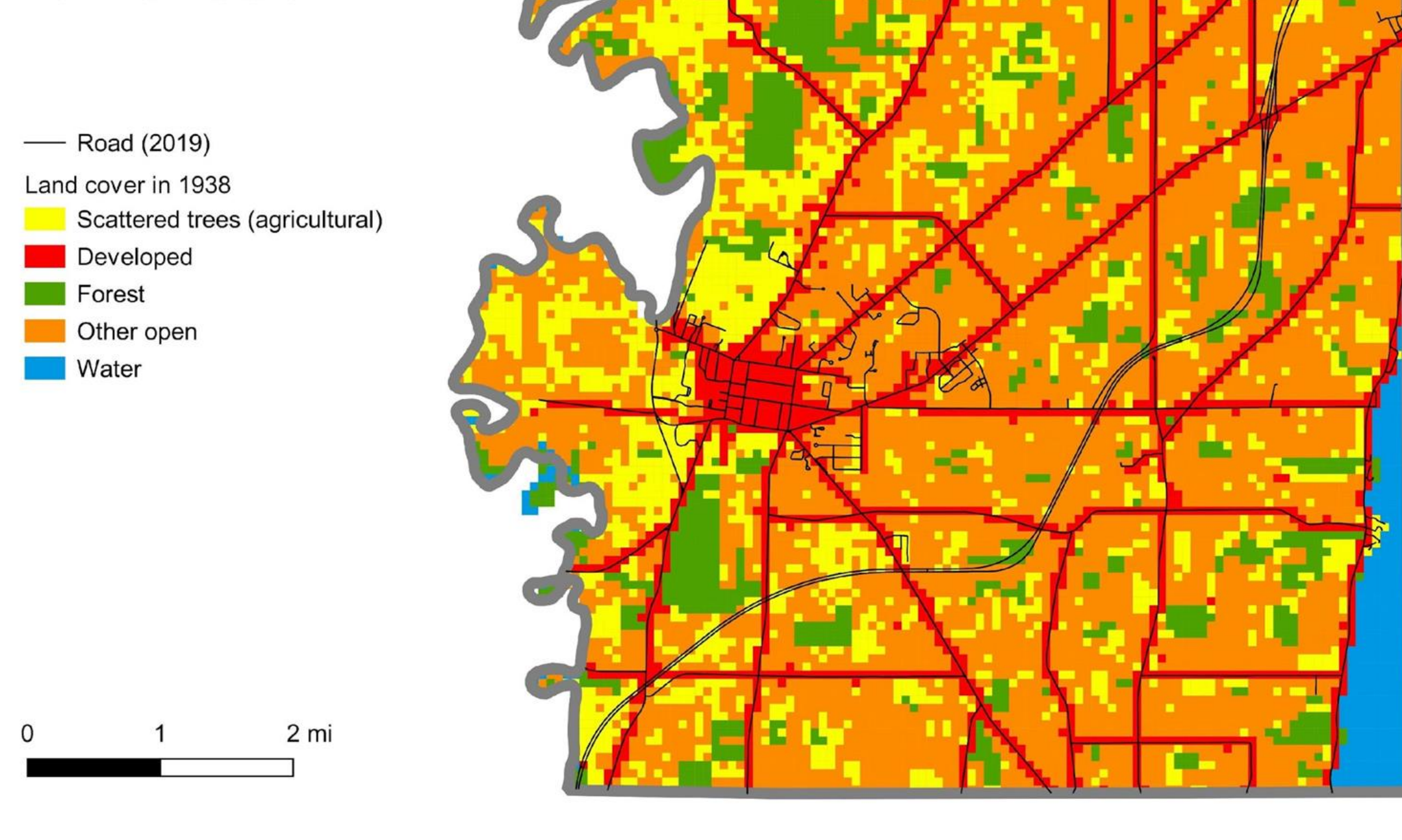
## Land cover in 2019
Town of Geneseo, New York State



Road (2019)
Land cover in 2019
Scattered trees (agricultural)
Developed
Forest
Other open
Water

0 1 2 mi

## Land cover in 2019
Within former (1938) scattered-tree agricultural lands



Road (2019)
Land cover in 2019
Scattered trees (agricultural)
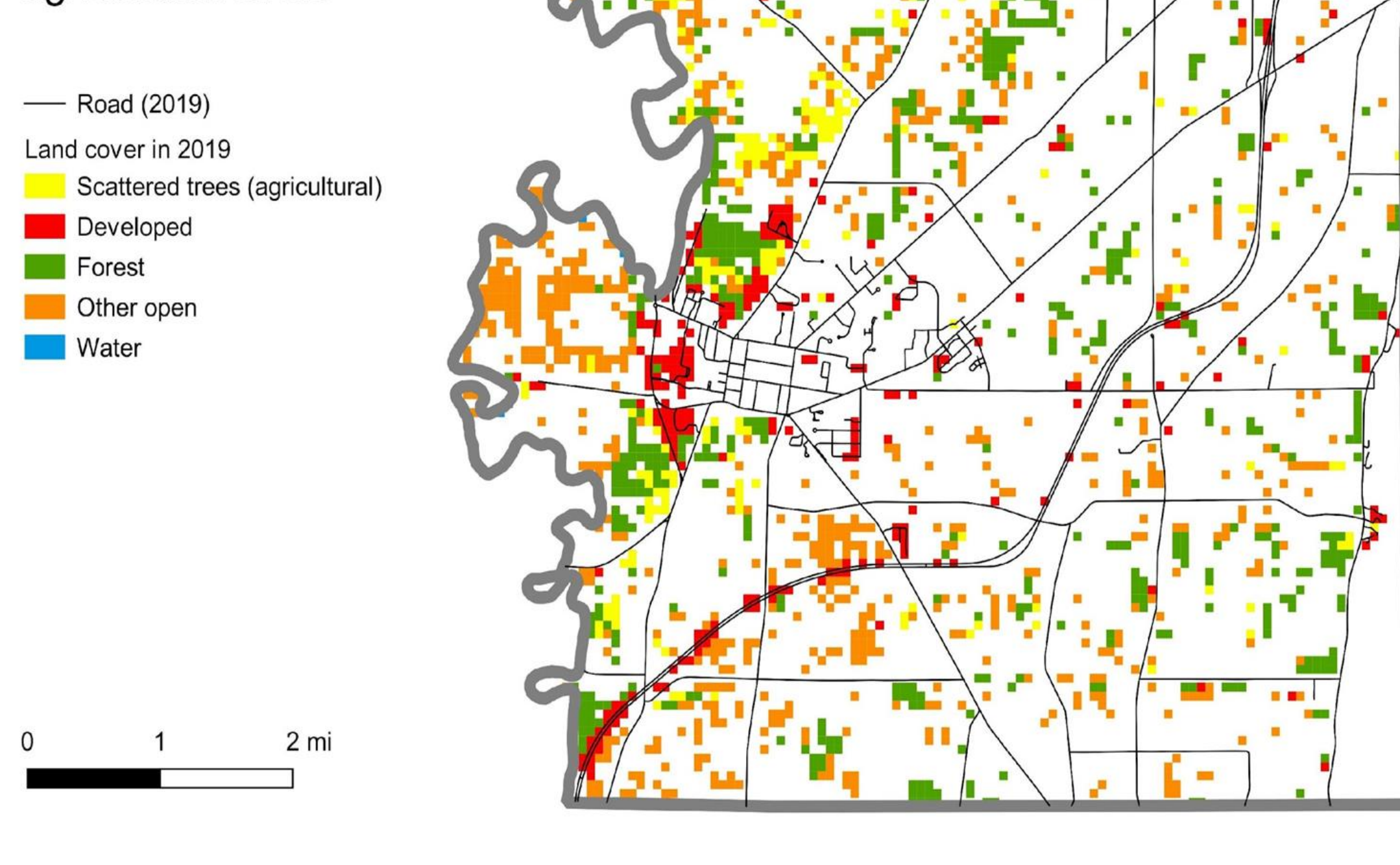Developed
Forest
Other open
Water

0 1 2 mi

Figure 4: Land cover maps, Town of Geneseo. The top two maps show land cover in 1938 and 2019 respectively. The bottom map shows change in scattered tree land units from 1938 to 2019.
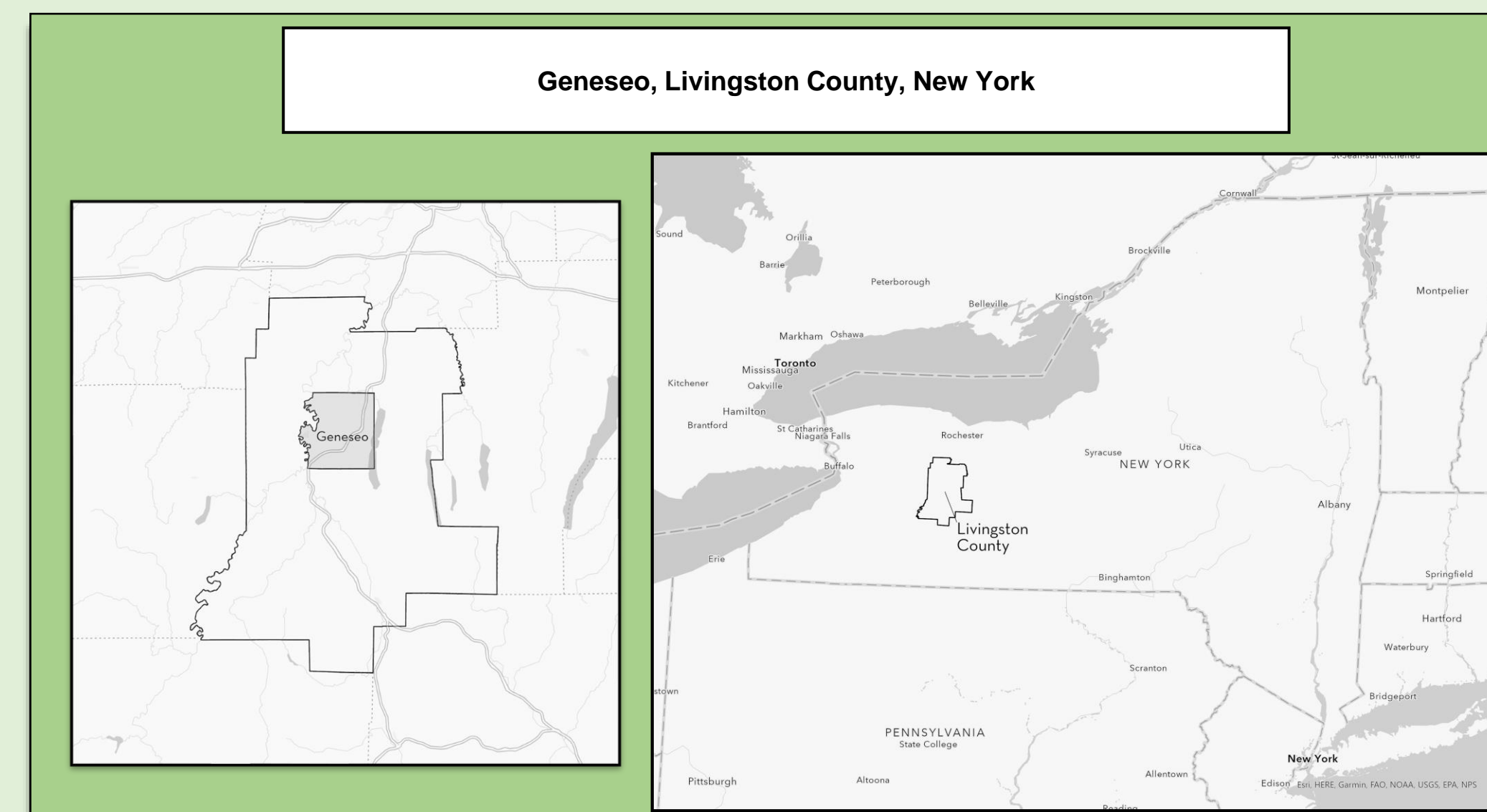
### Geneseo, Livingston County, New York



Figure 1: Study location map, Livingston County and Town of Geneseo, New York.
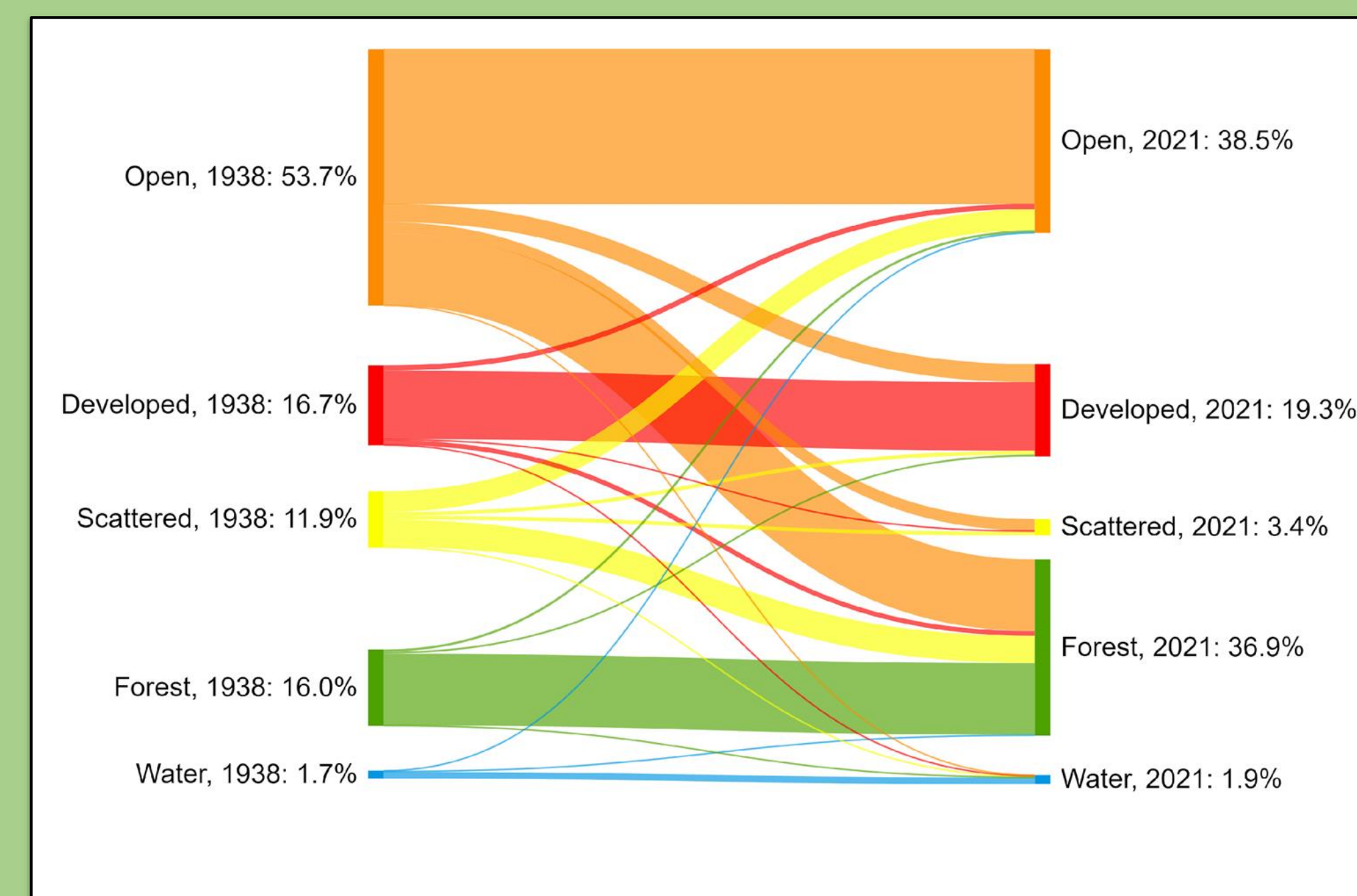
## Results

In both Livingston County and the Town of Geneseo, a significant decline was observed in scattered tree landscapes. Land cover change maps (Figure 4) and Sankey diagrams (Figure 5) show scattered tree and other land unit trajectories for Livingston County (1938 to 2021) and the Town of Geneseo from 1938 to 2019.

In Livingston County, sampled scattered tree land units declined from 11.9 percent in 1938 to 3.4 percent in 2021. In addition, 47% of scattered tree land units shifted to forest land units; 37% of scattered tree land units shifted to other open/agricultural land units; and 6% of scattered tree land units shifted to developed land units. Only 6 percent of scattered tree land units in 1938 remained scattered tree land units in 2021 in the county level.

In the Town of Geneseo, scattered tree land units declined from 17.8 percent in 1938 to 4.5 percent in 2019. In addition, 43% of scattered tree land units shifted to other open/agricultural land units; 30% of scattered tree land units shifted to forest land units; 14 percent of scattered tree land units remained scattered tree land units. Only 13 percent of scattered tree land units became developed land units in 2019.

### Livingston County, NY Land Unit Trends



Open, 1938: 53.7% — Open, 2021: 38.5%
Developed, 1938: 16.7% — Developed, 2021: 19.3%
Scattered, 1938: 11.9% — Scattered, 2021: 3.4%
Forest, 1938: 16.0% — Forest, 2021: 36.9%
Water, 1938: 1.7% — Water, 2021: 1.9%

### Town of Geneseo, NY Land Unit Trends



Open, 1938: 54.8% — Open, 2019: 46.5%
Developed, 1938: 14.1% — Developed, 2019: 23.5%
Scattered, 1938: 17.8% — Scattered, 2019: 4.5%
Forest, 1938: 10.2% — Forest, 2019: 22.7%
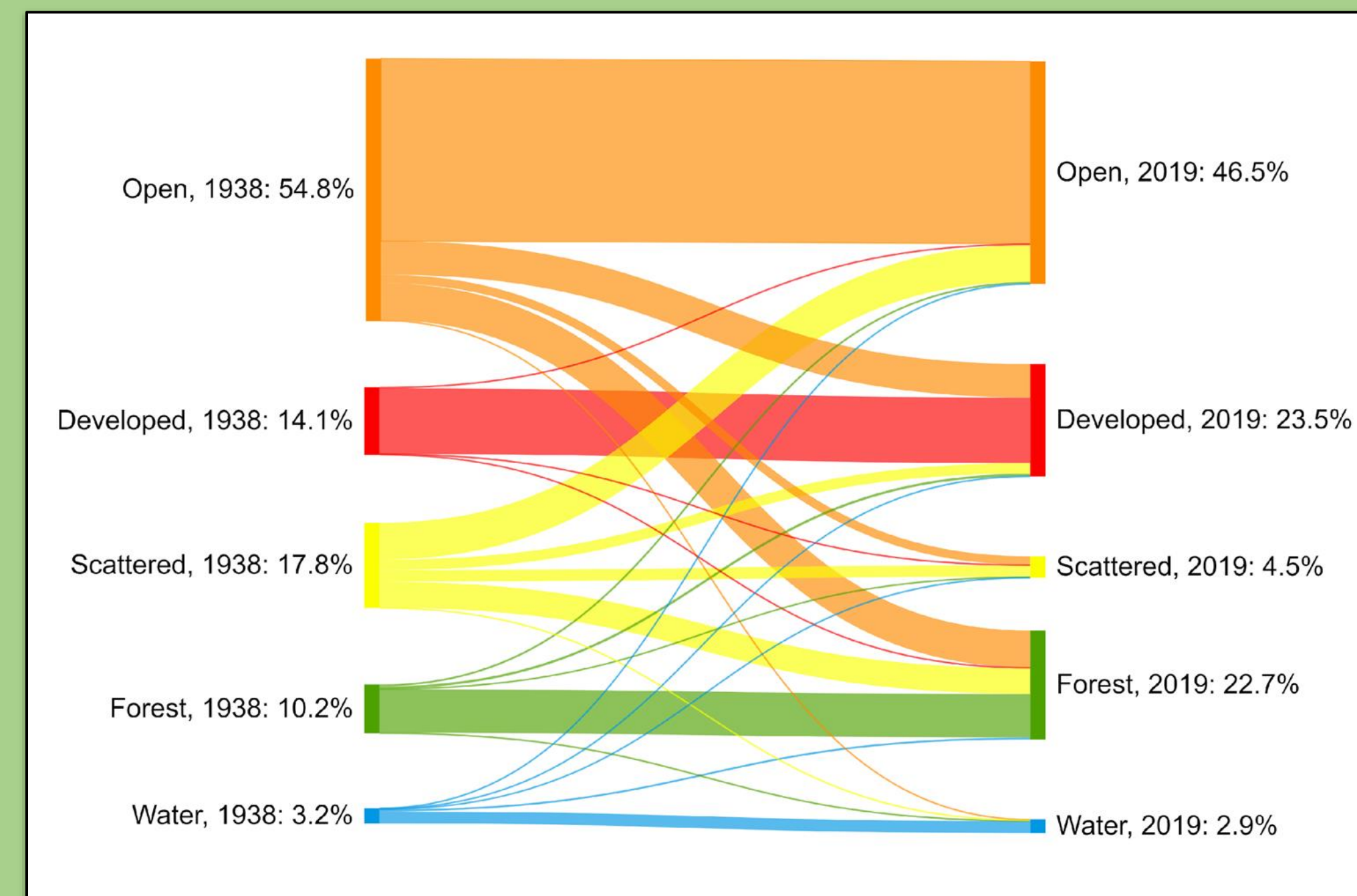Water, 1938: 3.2% — Water, 2019: 2.9%

Figure 5: Sankey diagrams showing land trajectories for the Town of Geneseo and Livingston County, New York from 1938 to 2019 and from 1938 to 2021 respectively.

## Discussion

Both Livingston County and the Town of Geneseo have experienced a notable decrease in scattered tree landscapes since 1938. The Town of Geneseo experienced a 76% loss in scattered tree land units between 1938 and 2019. In Livingston County there was a 71% loss in scattered tree land units between 1938 and 2021. This confirms anecdotal evidence communicated by longtime residents that the area has lost many of its landmark oak trees. Although natural mortality affected tree loss over the time period, a factor not addressed in this study, the results suggest that a variety of land use factors were also responsible for scattered tree loss.

As visualized in the Sankey diagrams, scattered tree land units shifted, in descending order, to forest, other open/ agricultural land, and developed land in both Livingston County and in the Town of Geneseo. Although it might be assumed that development pressures would have the greatest impact on scattered tree loss, this study shows that forest regeneration had the greatest impact as scattered trees were absorbed by closing forests. 43% and 37% of scattered tree land units in the town and county respectively shifted to forest land cover. This shift is assumedly the result of marginal farmlands being abandoned and forests regenerating, a land cover change common across rural areas of the Northeastern United States in the twentieth century. While many of the study area's formerly open-grown trees still stand within closed forests, the ecological and cultural function they serve as components of scattered tree landscapes have been diminished or lost.

37% of scattered tree land units in the town, and 30% in the county, were lost to agricultural land use. Although abandonment of marginal farmland has occurred in the study area, so too has development of the area's plentiful prime agricultural land, where it is not uncommon for mature oak trees to be felled to facilitate crop farming (Figure 6). Other research has confirmed, for example, that farmers perceive scattered tree farmland to be lower revenue generating compared to treeless agricultural landscapes (Plieninger et al.,2015).

A relatively small percentage of scattered tree land units in the town and county, 12% and 6% respectively, shifted to developed land units. This can be attributed primarily to the fact that the study area is rural and experienced modest population growth over the study time frame. Nonetheless, road and building construction have impacted scattered tree landscapes, but far less so than forest regeneration and agricultural land development.

Quantifying the loss of scattered tree landscapes in Livingston County, New York, and understanding their causes, has important ramifications. Locally, the area's scattered trees are mostly mature oaks. They are among the oldest and largest oak trees in New York State, and many stand in a relict oak savanna landscape formerly maintained by the Onöndowa'ga:' (Seneca) (Tulowiecki et al, 2019). As a result, the area's scattered trees have notable value as Onöndowa'ga:' cultural heritage. In addition, oak savanna is both a biodiverse and globally endangered vegetation community (McPherson 1997), the threats to which are vital to understand from a conservation and land management standpoint.

Scattered tree landscapes are culturally and ecologically important and they are affected by a variety of land use threats. This study suggests that in rural areas of the Northeastern United States, the most significant land use threats represent two sides of the same proverbial coin: forest regeneration occurring as marginal farmland is abandoned, and agricultural land conversion occurring as prime farmlands are developed.


Figure 6: Concern is expressed over the cutting of mature oak trees on this publicly posted sign sign (left) and a felled mature Oak tree sitting in a scattered tree landscape (right), Geneseo, New York

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