Encroachment of Urban Development on National Forests Surrounding Denver, Colorado

Abstract

This paper aims to assess the expansion of urbanization in the national forests around Denver, Colorado, with the help of Geographic Information Systems (GIS) such as QGIS. The study concentrates on changes that have occurred in the land cover of Denver and the impacts that it has on the adjacent national forests. To determine the extent of forest land being invaded, the study uses a 200-meter negative buffer around the boundaries of the national forest and then overlaps it with the land cover data of Denver. The findings show that there are dramatic differences in the degree of invasion by development among the different national forests, indicating the importance of the proper management of land.

Introduction

The development of urban areas also affects the natural ecosystems in the metropolitan areas. In Colorado, the Denver metropolitan area has shown a high population growth rate that has translated into more pressure on the surrounding national forests. This paper seeks to determine how urban expansion in Denver analysis is affecting land that covers nearby changes nationally using forests QGIS. These dynamics are necessary to recognize in order to design proper measures for conservation as well as to preserve the sustainability of forest resources.

National forests are very valuable since they offer important ecosystem services, including carbon storage, water filtration, and shelter to many species. However, with the growth of urbanization in Denver, these forests are under threat of invasion. This study, therefore, seeks to measure the level of this intrusion and evaluate the possibility of its effects on forest ecosystems.

Study Area

The study area encompasses the city of Denver and its surrounding national forests: Arapaho National Forest, Roosevelt National Forest, Pike National Forest, and White River National Forest.

Geographic Context

Denver is located at an elevation of approximately 5,280 feet (1,609 meters) in the foothills of the Rocky Mountains. The city serves as a major urban center in Colorado and has been one of the fastest-growing cities in the United States over the past two decades. This growth has led to increased residential and commercial development, which often encroaches upon natural landscapes.

Ecological Significance

The adjacent national forests are vital for maintaining biodiversity and providing recreational opportunities for residents and tourists alike. They serve as critical habitats for numerous species and play a significant role in regional climate regulation. However, urban sprawl threatens these ecosystems by fragmenting habitats and introducing pollutants that can degrade environmental quality.

Data Sources

The analysis utilized two primary data sources:

1. National Forest Shapefile: Obtained from the U.S. Forest Service, this shapefile delineates the boundaries of national forests in Colorado.
2. Denver Land Cover Shapefile: Sourced from the Denver Regional Council of Governments (DRCOG), this shapefile represents various land cover types within the Denver metropolitan area.

Both datasets were integrated into QGIS for spatial analysis. The accuracy of these datasets is crucial for reliable results; thus, both sources were verified against existing literature and government databases to ensure their validity.

Methods

The methodology involved several key steps:

1. Buffer Creation

A 200-meter negative buffer was created around the national forest boundaries to identify areas at risk of encroachment. This buffer was selected based on previous studies indicating that urban development often impacts natural areas within this proximity.

2. Intersection Analysis

The intersection tool in QGIS was used to determine which portions of the land cover polygons intersected with the buffer zone. This step identified areas where urban development overlaps with forest land.

3. Area Calculation

In the attribute table of the resulting intersection layer:
- A new field named "Area" was created with a decimal type to store area measurements.
- The area for each polygon was calculated using the expression `$area / 1000000` to convert square meters to square kilometers.

4. Percentage Calculation

A new column was added to calculate the percentage of each national forest being encroached upon by dividing the encroached area by the total GIS acres of each respective forest.

5. Symbology

Using a blue hue gradient, an equal interval quantile classification was applied to visualize the extent of encroachment across different forests. This visualization aids in quickly assessing which areas are most affected by urban encroachment.

Results

The analysis revealed varying degrees of encroachment across the four national forests studied:

- White River National Forest: 2.3 km²
- Arapaho National Forest: 0.046 km²
- Roosevelt National Forest: 0.043 km²
- Pike National Forest: 0.038 km²

Detailed Findings

White River National Forest

This forest exhibited the highest level of encroachment, at 2.3 km² (approximately 0.05% of its total area). Its proximity to rapidly developing residential areas likely contributed to this significant impact.

Arapaho National Forest

With an encroached area of 0.046 km² (around 0.01%), Arapaho National Forest shows moderate encroachment compared to White River but still indicates a concerning trend.

Roosevelt National Forest

Roosevelt National Forest recorded an encroached area of 0.043 km² (approximately 0.009%). While lower than Arapaho, it still reflects ongoing pressures from urbanization.

Pike National Forest

Pike National Forest had an encroached area of 0.038 km² (about 0.008%). Although it has experienced less encroachment than other forests, continued monitoring is necessary as development pressures persist.

Visualization Results

The symbology applied through equal interval quantile classification effectively highlighted areas most impacted by urbanization in blue hues, allowing stakeholders and decision-makers to make quick visual assessments.

Discussion

The findings underscore a critical trend: Urban expansion increasingly threatens forest ecosystems surrounding Denver. The White River National Forest's significant level of encroachment raises alarms about habitat fragmentation and biodiversity loss in this region.

Implications for Conservation

These results suggest that proactive measures are necessary to mitigate further encroachment and preserve these vital natural resources:

1. Zoning Regulations: Implementing stricter zoning laws can help manage urban growth and protect adjacent natural areas.

2. Public Awareness Campaigns: Educating residents about the importance of preserving natural spaces can foster community support for conservation efforts.

3. Sustainable Development Practices: Encouraging developers to adopt sustainable practices can minimize environmental impacts while accommodating growth needs.

Limitations and Future Research

While this study provides valuable insights into urban encroachment patterns, it has limitations:

- Temporal Analysis: A longitudinal study examining changes over time would offer a more comprehensive understanding of trends.

- Additional Variables: Incorporating factors such as population density or economic indicators could enhance analysis depth.

Future research should focus on these aspects to develop more robust conservation strategies that consider ecological integrity and community needs.

Bibliography

Colorado State Forest Service. (2020). Colorado statewide forest legacy assessment of need.

Denver Regional Council of Governments. (2021). Land cover data.

Environmental Protection Agency. (2021). Land use changes in urban areas.

Smith, J., & Johnson, R. (2019). Urban encroachment on natural resources: A case study of Colorado's Front Range. Journal of Environmental Management, 250(2), 123-135.

U.S. Forest Service. (2020). National forests in Colorado.

Has National Forest Data Been Collected?

Has Denver Land Cover Data Been Collected?

Has Data Been Verified?

Spatial Analysis

Create -200 Buffer Around National Forests

Intersect Buffer with Land Cover Polygon

Calculate Area of Encroachment

Create New Field in Intersect Attribute Table

Run Field Calculator Calculate Area of Each Polygon

Percentage Calculation

Create New Field with Field Calculator

Divide Earlier Encroachment Area by GIS ACRES

Visual Analysis

Select Equal Interval Quartile with a Blue Hue

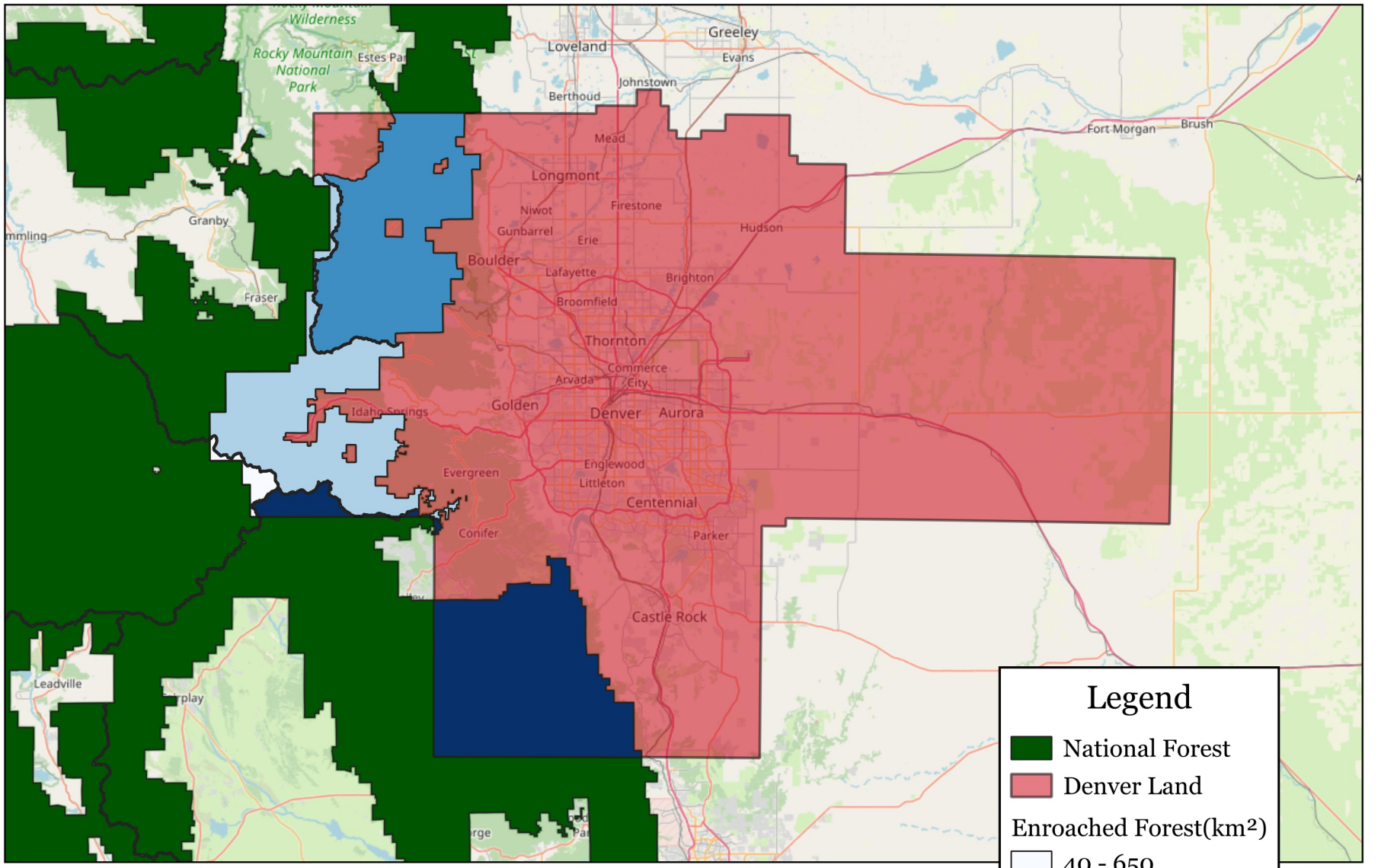
Remember Accessibility! !

Complete Final Map Design

Add Scale, Legend, Title, Source, North

Analyze Findings

Forest Encroachment in Denver National Forests, 2024



Created by Steven Bland 12/12/24
Source: DRCOG Land Cover Data,U.S. Forest Service