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Next Page--Introduction

Response of Forest to Climatic Events and Human Management at Fort Leavenworth, Kansas

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ABSTRACT

Characteristics and temporal changes in forest cover from 1987 to 1997 were documented on the basis of remote sensing for two study forests at Fort Leavenworth, northeastern Kansas. Eight Landsat 5 Thematic Mapper (TM) datasets from the month of July cover the study period, which included a major drought in 1988-1989 and flooding along the Missouri River in 1993. Other data sources included kite aerial photographs, digital orthophotos, tree-ring cores, climatic records, and ground observations. Three study areas were evaluated from Landsat TM datasets: (1) the entire Fort Leavenworth area; (2) an upland, hardwood forest composed mainly of oaks; and (3) a bottomland, softwood forest dominated by cottonwood. Normalized Difference Vegetation Index (NDVI) values were derived from these three study sets and subjected to image differencing and principal-component analysis. The TM band 5:4 ratio was also analyzed for the two study forests. Values and trends derived from Landsat imagery were compared to data on tree-ring growth in upland oaks and regional climatic events.

Annual growth of tree rings in upland oaks is tied closely to precipitation and the Palmer Drought Severity Index (PDSI); however, changes in NDVI values lag one to two years behind the onset of climatic events, particularly drought episodes. During the first year of drought (1988), vegetation cover in the upland and bottomland forests reacted in different ways: with a slight decline in the upland forest and a slight increase in the bottomland forest. The increased vegetation in the bottomland forest presumably resulted from more understory growth in dry hollows and potholes. In the second year of drought (1989), both forests suffered a marked decline in vegetation cover. NDVI values reached their minima for all categories (whole area, upland forest, and bottomland forest) in 1990, even though precipitation and tree-ring growth increased substantially that year. We conclude that changes in Landsat-derived NDVI values are out of phase with climatic events and variations in tree-ring growth for both upland and bottomland forests in northeastern Kansas and northwestern Missouri.

Overall change (1987 to 1997) for NDVI values is down slightly for all categories of evaluation. This probably reflects reduced precipitation throughout the study period compared to the long-term average. Changes in vegetation took place mainly on the forest margins. Such changes are thought to result from microclimatic stress at forest edges. The bottomland study forest also was impacted by severe flooding in 1993. Routine human activities may have resulted in minor changes along the margins of both study forests. The bottomland forest was affected by intentional burning of the adjacent prairie in April 2000. Cottonwood trees at the forest edge were killed or injured by the prairie fire, which penetrated the forest understory some distance.

Next Page--Introduction

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