Analyzing Land-Use Change at Different Scales in Central Georgia

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Abstract

Growth and development in a region affect the environmental quality of its immediate area and surrounding localities. Such effects are of great concern on military lands because of their ecological importance and the proactive management approach of the military. Military installations support a number of endangered and threatened plant and animal species, and habitat preservation is of prime importance. Yet the survival of these species must be considered in relation to human use of environment and at various scales of resolution. Therefore, we used field experiments to test local impacts, remote sensing data to document changes over time for the entire installation, and the Regional Simulation Model (RSim) to simulate the effects of growth and development in a five-county study region surrounding Fort Benning, Georgia. Changes in air and water quality, noise conditions, and habitats of keystone species are analyzed under different scenarios. Currently implemented scenarios are population growth, a proposed road improvement program, and a new military training facility within Fort Benning. Growth rules are applied to the land cover as part of each scenario. Different components of RSim model the effects of such land cover change on environmental and ecological qualities.

KEYWORDS: Fort Benning, indicators, land use change, military land, simulation model

Introduction

The Fort Benning Military installation is home to a number of rare and threatened plant and animal species. At the same time the military training on the installation results in some areas being cleared or trampled. Yet, natural resource management and military activities here have to be carried out without jeopardizing any threatened or endangered plant or animal species and while maintaining appropriate quality of noise, soil, and air (Efroymson et al. in press). The conservation of the habitat of species and environmental quality is of great importance to planners and developers on the installation and also in the region around it.

APPROACH

Selecting appropriate ecological indicators for the region was our first task. One of the biggest challenges in selecting ecological indicators was determining the criteria for their use. Therefore, we did a thorough analysis of the scientific literature and talked with resource managers and other researchers at Fort Benning in order to develop a list of criteria for indictor selection (Dale and Beyeler 2001). Then field studies confirmed our hypothesis that a suite of ecological indicators is needed to characterize key environmental conditions at Fort Benning (Dale at al. 2004). This suite captures spatial and temporal scales of interest and includes the following: soil microbiology (Peacock et al. 2001); vegetation indicators (Dale et al. 2002); stream chemistry, physical conditions, and biota (Maloney et al. in press); and landscape indicators (Olsen et al. in press). In general, many ecological impacts can be captured by the proportion of a watershed that is denuded (defined here as bare ground on slopes greater than 3% and in paved and unpaved roads).

The creation and use of roads and trails is one of the main effects of land clearing. Furthermore, roads and vehicle use change the environmental conditions in which they occur (Forman et al. 2003). One way to categorize these effects is by the spatial scale of the cause and the impacts. Roads may be viewed from the perspective of road segments, road networks, or roads within political boundaries such as counties. Our work on the effects of roads within central Georgia in the southeastern United States allowed us to examine the environmental impacts at four spatial scales that included the Fort Benning Military Reservation. These scales are a second-order catchment, a third-order watershed, the entire installation, and the five-county region surrounding including Fort Benning. The military reservation supports foot and mechanized infantry training as well as habitats for rare species associated with longleaf pine (*Pinus palustris*) forests. The five-county region includes the city of Columbus, several suburbs and smaller towns, and agricultural and forest land.

The analysis involved different treatments at different scales (as described in detail in Dale et al. in press A). Impacts from an experimental path made by a tracked vehicle were examined at the catchment level. Land-cover changes discerned through remote sensing data over the past three decades were considered at the watershed and installation scales. A regional simulation model was used to project changes in land cover for the five-county region. Together, these analyses provide a picture of how the environmental impacts of roads and vehicles can occur at different spatial scales. Following tracked vehicle impact with a D7 bulldozer, total vegetation cover responded quickly, but specific plant species recovered differentially. Soils were compacted in the top 10 cm and are likely to remain so for some time. Examining the watershed via satellite imagery from 1974 to 1999 revealed that forest conversion was highest near unpaved roads and trails. At the installation scale, major roads as well as unpaved roads and trails were associated with most of the conversion from forest to nonforest land.

For the five-county region, most of the conversion from forest to nonforest is projected to be due to urban spread rather than the direct impact of roads. To create these projections, we used the Regional Simulation Model (RSim), a scenario-based growth model that indicates the changes in land cover, air and water quality and habitat of species as a result of various growth and development activities (Dale et al. in press A). The model incorporates roads as part of the urban growth module. The road development scenario is based on the Governor's plan for new roads in the state. The simulated changes are useful to quantify the risks and problems associated with military use and development.

Anthropogenic influences on the region have been long-standing and intense (Dale et al. in press B). Only 4 percent of the native longleaf pine forest remains intact in the southeastern United States. Besides the loss of species, habitats, and ecosystem services associated with longleaf pine forests, environmental concerns of the region include air, water, and noise pollution. The mix of federal and private ownership serves to complicate land management issues that will likely become even more difficult as Columbus continues its projected growth along the northern border of Fort Benning.

The knowledge of potential futures for the area allows decision makers to better consider options for environmental protection. A main lesson from this analysis is that regional simulation models are a cost-effective way to assess long-term environmental implications at different scales of resolution. These results lead to questions about appropriate metrics of road impacts.

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