UNH Research Shows Land Cover Changes Affect Summer Climate

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DURHAM, N.H. -- While climate may be impacted by carbon dioxide emissions, aerosols, and other factors, a new study co-authored by University of New Hampshire scientist George Hurtt offers further evidence that land surface changes may also play a significant role.

Using data and computer models from NASA, the National Oceanic and Atmospheric Administration and other agencies, the study of summer climate in the United States reported that changes in land cover, particularly vegetation, over the past 300 years may have impacted regional temperatures and precipitation.

“Independent studies have suggested that the U.S. has warmed on average since the Industrial Revolution. Our research suggests that this warming might have been even greater had certain land cover changes not occurred, “ said Hurtt of UNH’s Institute for the Study of Earth, Oceans, and Space and the Department of Natural Resources. Somnath Baidya Roy, a research scientist at Princeton University, was lead author of the study that appeared in a recent issue of the Journal of Geophysical Research-Atmospheres. Co-authors include Hurtt, Christopher Weaver of Rutgers University, and Stephen Pacala, also of Princeton.

The study found that since 1700, land cover changes produced a significant cooling effect of more than one degree Fahrenheit in parts of the Great Plains and Midwest as agriculture expanded and replaced grasslands. Farmlands tend to create lower temperatures through increased evaporation. A warming effect was found along the Atlantic coast where croplands replaced forests.

Compared to forests, croplands are less efficient in transpiration, a daytime process where water evaporates from leaves during photosynthesis and cools the air. A slight warming effect was also observed across the Southwest, where woodlands replaced some deserts.

The study also found that land cover changes could impact local precipitation, but not as significantly as they affect temperature, because U.S. summer rainfall is not highly dependent on local land cover and evapotranspiration. The relatively strong cooling over the central U.S. has probably weakened the temperature difference between land and the Gulf of Mexico, slowing the northward movement of weather systems and resulting in enhanced rainfall across Texas. Consequently, the air masses reaching the Central Lowlands region, including Illinois and Indiana are drier, causing rainfall reductions.
“Land cover change is not uniform. Most people associate land cover change with deforestation, but the changes in the U.S. are more complex, creating a temperature signal that is more difficult to study,” said Roy. The forest cover in the U.S. has actually increased in the last 100 years mainly due to farm abandonment in the East and fire suppression in the West. In addition, large parts of the Great Plains have been converted into irrigated croplands, which tends to produce cooling.

The research also carries additional implications. “It is important to understand the effects of changing land cover, because it can mitigate or exacerbate greenhouse warming,” said Roy. “In the U.S. over the past 100 years, it seems to be offsetting greenhouse warming. The opposite is probably true in most other parts of the world. This finding has also been supported in previous research.”

Unlike previous studies that simulated and compared past and present climates with potential and current vegetation respectively, this research used the Ecosystem Demography model in conjunction with a regional climate model to track changes in land cover characteristics for nearly 300 years. “The ED model is a technological breakthrough and enables scientists to study the potential impacts of land use and climate change across a wide range of scales, from individual plants to continental regions,” said Hurtt.