Erosion Forecast

Models predict climate change impacts on erosivity from 2000-2100

Mark A. Nearing

Greenhouse gas emissions are expected to increase global temperatures and cause significant rainfall changes.

These predicted global climate changes are already impacting the United States. Historical weather records over the last century show that the number of rain days and frequency of high-intensity rainfall have increased.

Chances are less than one in 1,000 that these precipitation patterns would have changed under a more stable climate. We also have good scientific reason to believe that these types of changes will continue into the next century. Some parts of the United States are expected to become wetter while others become drier.

As the greenhouse effect causes rainfall changes, soil erosion rates will also change. We call the power of rain to cause erosion the "erosivity" of rainfall. Computer simulation models indicate that for every 10 percent change in total rainfall we can expect a 20 percent change in surface water runoff and about a 17 percent change in soil erosion. The major change is due to precipitation intensity changes rather than total rainfall.

Runoff changes can increase flooding, which has become a major problem recently in many parts of the United States. In recent studies at the USDA-Agricultural Research Service, Purdue University, we compared results from two large climate change models. One came from the Hadley Centre in the United Kingdom and the other was developed at the Canadian Centre for Climate Modelling. The models are called "Coupled Atmospheric-Oceanic Global Circulation Models (GCM)."

Study results using the models predict significant erosivity changes for the 21st century. Erosivity calculated from the Hadley model indicate an erosivity increase over the eastern United States including most of New England and the mid-Atlantic states as far south as Georgia. It also predicts an erosivity increase for the northern United States, southern Canada, and parts of Arizona and New Mexico.

The model shows erosivity decreases in the future for parts of California, Nevada, Utah, western Arizona, Texas and a large portion of the southern central plains from Texas to Nebraska.

The Canadian Centre model also predicted an erosivity for the northern United States including New England and southern Canada. Similar to the Hadley model, results indicated an erosivity decrease across much of the southern plains from Texas to Nebraska. However the Canadian Centre boundary extended west of the Hadley model area. The Canadian Centre model did showed inconsistent results for the southeastern United States.

Both models suggest that the magnitude of erosivity changes is expected to increase throughout the century. The average magnitude of change for the first half century was estimated at 14 percent from the Hadley simulations and 26 percent from the Canadian model. Average magnitudes for the entire century were calculated at 18 percent and 56 percent.

The magnitude of climate change impacts on erosivity is still in question. However, the GCM study results provide a good indication that significant erosivity changes are likely to occur.

What remains unclear is how erosivity changes will translate to actual erosion rate changes. Feedback from an erosional system may answer this question. For example, increased atmospheric CO_2 concentrations and rainfall can increase biomass crop production. Increased biomass translates to increased canopy and residue covers, which protect the soil from increased erosivity.

We are evaluating some of the effects using more detailed simulation modeling methods. The results will help us plan better conservation strategies, lead to better, more targeted conservation strategies and develop a better soil resource base for growing food in this country.

Mark A. Nearing is an agricultural engineer with the National Soil Erosion Research Laboratory, USDA-Agricultural Research Service, 1196 SOIL Building, Purdue University, West Lafayette, IN 47907-1196, USA; 765-494-8673, fax 765-494-5948, mnearing@purdue.edu.