Water table depth tied to droughts in Great Plains

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Dust Bowl farm in Coldwater District, near Dalhart, Texas. This farm is occupied. Others in this area have been abandoned. Photographed by Dorothea Lange in June 1938. Image from the Library of Congress, Farm Security Administration-Office of War Information Collection.

(PhysOrg.com) -- Will there be another “dust bowl” in the Great Plains similar to the one that swept the region in the 1930s? It depends on water storage underground. Groundwater depth has a significant effect on whether the Great Plains will have a drought or bountiful year.

Recent modeling results show that the depth of the water table, which results from lateral water flow at the surface and subsurface, determines the relative susceptibility of regions to changes in temperature and precipitation.

"Groundwater is critical to understand the processes of recharge and drought in a changing climate," said Reed Maxwell, an atmospheric scientist at Lawrence Livermore National Laboratory, who along with a colleague at Bonn University analyzed the models that appear in the Sept. 28 edition of the journal *Nature Geoscience.*

Maxwell and Stefan Kollet studied the response of a watershed in the southern Great Plains in Oklahoma using a groundwater/surface-water/land-surface model.

The southern Great Plains are an important agricultural region that has experienced severe droughts during the past century including the "dust bowl" of the 1930s. This area is characterized by little winter snowpack, rolling terrain and seasonal precipitation.

While the onset of droughts in the region may depend on sea surface temperature, the length and depth of major droughts appear to depend on soil moisture conditions and land-atmosphere interactions.

That's what the recent study takes into account. Maxwell and Kollet created three future climate simulations based on the observed meteorological conditions from 1999. All included an increase in air temperature of 2.5 degrees Celsius. One had no change in precipitation; one had an increase in precipitation by 20 percent; and one had a decrease in precipitation by 20 percent.

"These disturbances were meant to represent the variability and uncertainty in regional changes to central North America under global model simulations of future climate," Maxwell said.

The models showed that groundwater storage acts as a moderator of watershed response and climate feedbacks. In areas with a shallow water table, changes in land conditions, such as how wet or dry the soil is and how much water is available for plant function, are related to an increase in atmospheric temperatures. In areas with deep water tables, changes at the land surface are directly related to amount of precipitation and plant type.

But in the critical zone, identified here between two and five meter's depth, there is a very strong correlation between the water table depth and the land surface.

"These findings also have strong implications for drought and show a strong dependence on areas of convergent flow and water table depth," Maxwell said. "The role of lateral subsurface flow should not be ignored in climate-change simulations and drought analysis."

The simulations were performed on LLNL's Thunder supercomputer and the work was supported by the LLNL climate change initiative.

Provided by Lawrence Livermore National Laboratory