Sand dunes reveal unexpected dryness during heavy monsoon

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Sand dunes in northern China, such as these in the Otindag dunefield, are a rich source of information about past climates in Asia. Research led by University of Wisconsin-Madison geographer Joseph Mason has uncovered evidence of an unexpectedly dry climate in northern China during a strong monsoon cycle 8,000 to 11,500 years ago. The results challenge common assumptions about future climate changes -- including likely effects of the stronger monsoon rains predicted by many climatologists as global temperatures warm -- and suggest that Chinese desert margin regions may actually become drier, with potentially negative impacts on water resources, grazing, and air quality. Photo by: Joseph Mason, UW-Madison

(PhysOrg.com) -- The windswept deserts of northern China might seem an odd destination for studying the heavy monsoon rains that routinely drench the more tropical regions of Southeast Asia.

But the sandy dunefields that mark the desert margin between greener pastures to the south and the Gobi Desert to the north are a rich source of information about past climates in Asia, says University of Wisconsin-Madison geographer Joseph Mason. Wetter periods allow vegetation to take root on and stabilize sand dunes. During dry spells, plants die off and the dunes are more active, constantly shifting as sand is blown away and replenished.

Such patterns of dune activity provide a history of the area's climate — if one can read them, Mason says. "When did those periods of stability or activity occur and from that, what can we infer about climate change?"

As reported in a new paper in the October issue of the journal *Geology*, Mason and colleagues mapped sand dune activity across northern China and found unexpectedly high levels of mobility and change 8,000 to 11,500 years ago, a time period generally thought to have a wetter climate. The result challenges existing ideas about the monsoon's regional influence and could impact future climate predictions.

Today, the dunes are at the edge of the monsoon region and the scientists expected to find close correlation between precipitation in the dunefields and the strength of the monsoon.

What they found instead was rather surprising. "They turn out to be almost completely out of phase," Mason says. "Where we find lots of active dunes turns out to be a time when the monsoon system is supposed to have been stronger in southern and central China."

Part of the explanation may lie in local patterns of atmospheric circulation. At the peak of the summer monsoon, central China experiences both heavy summer rainfall and strong upward airflow. That upward flow tends to be balanced out by more downward air motion —

which suppresses precipitation — in areas north and west of the monsoon core.

Regional climate modeling data from the UW-Madison Center for Climatic Research, led by co-author and UW-Madison professor of atmospheric and oceanic sciences Zhengyu Liu, shows that this pattern may have been strengthened between 8,000 and 11,500 years ago. The models also show high summer temperatures at that time, which would have increased evaporation and further reduced the moisture that supports dune-stabilizing plants.

This pattern of climate change had been described for areas distant from the monsoon, like Central Asia around the Caspian and Aral Seas and in northern Mongolia. However, Mason says, "It hasn't really been recognized that this effect could be going on in northern China, which is where our study sites are. What it means is there's much more of a contrast in climate change across a fairly short distance."

The new findings relied on a technique called optically stimulated luminescence (OSL), which dates the last time the sand was exposed to sunlight. Radiocarbon dating methods are of limited use since sand typically contains little or no organic material. The OSL method identifies time periods when the sand was actively moving around, indicating little precipitation, and times when dunes were stable.

Mason's previous work in the area suggests that moisture and precipitation are the most significant factors in determining the activity of the Chinese dunes. The new results mean that common assumptions about the effects of future climate changes — including the increased monsoon rainfall predicted by many climatologists — may be incorrect.

"If monsoon rainfall increases in southern China over the next century, the logical assumption would be that these dunes would become more stable as more precipitation also reaches the dune fields and increases vegetation cover," Mason says. "That may not be true… The dunes can become active and the climate there can become drier even when the monsoon is getting stronger."

Even if future rainfall in northern China isn't reduced by changing air circulation patterns as it was in the past, rising temperatures will undoubtedly increase evaporation, he says, exacerbating the water shortages that already plague the area. An accompanying increase in sand dune activity would reduce available grazing land and worsen air quality.

"If it's drier you have less vegetation and the dunes are active. There will almost certainly be more dust produced, which is a major environmental hazard. Some of the dust from northern China actually reaches Korea, Japan and even the western U.S.," says Mason.

Source: University of Wisconsin-Madison (news : web)

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