RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

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Freshwater floods drive salt into arid region aquifers

For people living in arid ecosystems, groundwater replenished during seasonal flooding is typically their most important source of freshwater. Yet these same floods may also be responsible for temporarily increasing the salinity of the vital freshwater stores, a relationship shown for the austral summer flooding of the Kuiseb River in Namibia. Between 2006 and 2008, *Amiaz et al.* recorded the effect of 12 floods on soil water storage, groundwater electrical conductivity (a measure of salinity), and solute movement throughout various layers of the subsurface along the river. The researchers' primary concern was understanding how soluble salts residing in the vadose zone, the subsurface layer that lies between the groundwater table and the surface, make their way into the aquifer.

Through in-field measurements and laboratory soil column experiments, the authors found that as floodwater travels along the surface it triggers a compression wave that moves down through the sandy sediments that compose the channel bed, destabilizing salts in the vadose zone and pushing them into the groundwater. As the floodwater itself percolates through the subsurface, additional salts dissolve into it, further increasing groundwater salinity. The authors noticed that while the first flood of the season leads to the largest leap in groundwater salinity, subsequent flooding can draw even more salt out of the vadose zone due to the rising water table and the subsequent saturation of the vadose zone sediments. They note that it is only upon the arrival of substantial floodwater to the groundwater stores that dilution can compensate for the increased salinity. (*Water Resources Research*, doi:10.1029/2011WR010747, 2011) —CS

B. Tatarski (BGU) and H. Kolb (DFRN)

(Left) Sensors installed in the Kuiseb River during the winter dry season record changes in groundwater salinity, solute transport, and soil water storage during (right) summer flooding.

Postfire debris flows occur quickly after rainfall starts

Areas damaged by forest fires can be vulnerable to debris flows because vegetation is no longer holding dirt and rocks in place, and debris flows in burned areas can be triggered by much less rainfall than would be needed to trigger a debris flow in an unburned area. Such debris flows are common in burned steep terrain in Southern California and sometimes cause significant damage to property and even loss of life—for instance, 16 people died in debris flows above San Bernardino on 25 December 2003.

Robert Leeper

Postfire debris flow damage after the 6 February 2010 storm, La Cañada Flintridge, Calif.

To better understand the conditions that lead to debris flows, *Kean et al.* measured properties including rainfall, channel bed pore fluid pressure, and hillslope soil water content for 24 debris flow events that occurred in five different watersheds that burned in the 2009 Station and Jesusita fires in the San Gabriel and Santa Ynez mountains.

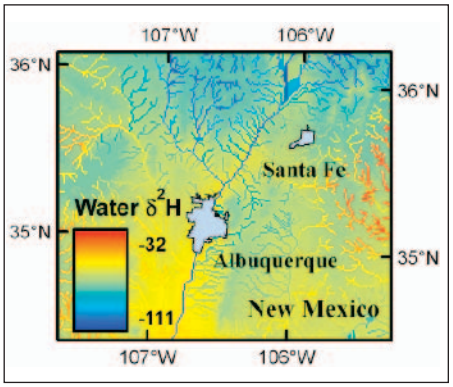
They looked at the timing of rainfall and debris flow events. Although there were differences between the sites and between different events at the same site, the researchers consistently found that debris flow events began very quickly—within 30 minutes—after the onset of a rainstorm. Debris flow was not found to be correlated with soil moisture, and debris flows were initiated primarily by surface water runoff rather than by landslides. This was true across sites of different size and different geologic material.

The data could be useful in constraining future models of debris flow following fires, but more important, they show that to give enough practical lead time, early warning of debris flow must rely on weather forecasts—once a heavy rain starts, it is too late to warn people of an impending debris flow. (*Journal of Geophysical Research-Earth Surface*, doi:10.1029/2011JF002005, 2011) —EB

New map of surface water isotope variation

The isotopic composition of hydrogen and oxygen in water varies in waters of different sources, and isotopic composition changes through mixing of water masses and through processes such as evaporation. For instance, the isotope composition in surface water is often different from the isotope composition in precipitation and groundwater. This isotopic variation can be useful in a variety of hydrological, ecological, and climate science studies. *Bowen et al.* developed a model based on geographic information system data to predict long-term annual average surface water isotope ratios across the United States. They validated their model with data from a water monitoring program and showed that their map reproduced the observed pattern of isotopic variation across the United States.

They found that spatial variability in the isotopic composition of precipitation was the dominant source of variability in isotopic composition in surface



Modeled hydrogen isotopic composition (δ^2H) of streams in central New Mexico (United States), shown superimposed on mean annual precipitation δ^2H values [after Bowen et al., *2011].*

water. Such maps of isotope composition could be used for a variety of applications, for example, to help locate the geographic source of a particular sample of water. (*Journal of Geophysical Research-Biogeosciences*, doi:10.1029/2010JG001581, 2011) —EB

Protactinium-thorium ratio as a proxy for ocean circulation

The Atlantic meridional overturning circulation (AMOC) transports water and heat over long distances in the Atlantic Ocean and is believed to have an important effect on Earth's climate. Knowing how strong the AMOC was in the past is essential to understanding past climate. One proxy researchers have used to assess the past strength of the AMOC is the sedimentary protactinium-thorium ratio (^{231}Pa/^{230}Th). Both ^{231}Pa and ^{230}Th are produced through decay of uranium at a constant rate in the ocean water column, but ^{230}Th does not last long enough in the water to be transported away from the location where it was produced, while ^{231}Pa has a longer residence time in the water. Therefore, sedimentary ^{231}Pa/^{230}Th ratios could provide information about the strength of past ocean circulation.

However, some studies have questioned whether this ratio is sensitive to factors other than ocean circulation, limiting its use as a proxy. To assess ^{231}Pa/^{230}Th ratios as a proxy for ocean circulation, *Lippold et al.* compared new measurements of ^{231}Pa/^{230}Th from sediments in the north Brazilian margin to water column data and the output of a circulation model. They found that the sedimentary ^{231}Pa/^{230}Th ratio was driven predominantly by the AMOC, thus verifying that ^{231}Pa/^{230}Th does work well as a proxy for ocean circulation. (*Geophysical Research Letters,* doi:10.1029/2011GL049282, 2011) —EB

Sediments sampled during the October 2009 cruise of the R/V Marion Dufresne *were combined with sediments from the Bremen Core Repository and literature data to obtain a comprehensive protactinium-thorium ratio (^{231}Pa/^{230}Th) depth transect to assess the use of ^{231}Pa/^{230}Th as a proxy for ocean circulation.*

—ERNIE BALCERAK and COLIN SCHULTZ, Staff Writers