soil moisture was found to be as great as, or greater than, early season snowpack.

The extra information available from dynamical models could lead to skilful forecasts with lead times several months longer than are available at present. Dynamical forecasts may also lead to a reduction of errors in the most unusual years when the forecasts are often needed most, but statistical methods are less reliable because the number of precedents is small. Statistical methods are also based on stationarity — the idea that the future will behave in much the same way as the past; this is a questionable assumption in the face of evolving land uses and a changing climate.

The study by Koster and colleagues[2] is a substantial contribution to the burgeoning field of what has been called hydrologic forecast science[9]. This emerging branch of the hydrologic discipline seeks to understand predictability, to prioritize investments that lead to the greatest reductions of uncertainty and to build a culture of innovation informed by forecast verification. This study shines a light into the future, guiding the research community to new frontiers and helping water managers to cope with variable and dwindling supplies. ❐

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GEOMORPHOLOGY

Crayfish at work

‘Ecosystem engineering’ might bring to mind images of humans dredging channels or building artificial reefs, but many creatures are capable of changing the environment in which they settle. Ponds forming behind dams that were built and reinforced by generations of beavers are a common sight in temperate forests. Coral mounds and reefs rise from the ocean floor in tropical and cold-water settings. And in lakes and rivers, invasion by masses of zebra mussels has a marked effect on water clarity and nutrient content.

Even the rather small and simple signal crayfish can move substantial amounts of sediments in lake and stream beds, according to Matthew Johnson and colleagues at Loughborough University, UK (*Geomorphology* doi:10.1016/j.geomorph.2010.07.018; 2010). They found that the 10-cm-long crustaceans were able to move an average of 1.7 kg m^{-2} of sediment in a day.

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The crayfish in question were placed in individual aquaria with a range of substrates, for periods ranging from 30 minutes to four days. Johnson and colleagues used laser scans to create a digital elevation model for the surface of the substrate before and after each crayfish’s occupation. The crayfish were generally quite busy, burrowing for shelter and pushing the displaced material into mounds. But although the resultant pits and mounds were the most readily visible signs of alteration, they accounted for less than one quarter of the total sediment disturbance.

Instead, most of the gravel was redistributed as the crayfish moved and foraged, shifting the substrate as they went. The crayfish were even observed lifting individual grains with the claws on their first and second pairs of walking legs and rotating them in front of their mouths. They were also surprisingly strong, able to move grains up to six times heavier than themselves.

Johnson and colleagues suggest that in the natural environment, the shifting of larger grains by the active crustaceans could promote the mobilization of finer sediments in streams and waterways, and could also counter the consolidation of gravels by the flowing water. Though indigenous to the western United States, signal crayfish have recently been introduced throughout Europe and Japan to counter the loss of native species to a crayfish plague. The authors point out that modification of the stream bed triggered by a large influx of the crayfish could be detrimental to the native benthic communities.

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