River-Level Forecasting Shows No Detectable Progress in 2 Decades

And you thought weather forecasters had it tough. Hydrologists looking to forecast the next flood or dangerously low river flow must start with what weather forecasters give them—predictions of rain and snow, heat and cold—and fold that into myriad predictive models. Then those models must in turn forecast how rain and any melted snow will flow from rivulet to river while liable to loss to evaporation, groundwater, reservoirs, and farmers’ fields. During their century in the forecasting business, hydrologists have developed a modicum of skill, but a newly published study fails to find any improvement during the past 20 years in forecasting river levels out to 3 days.

“It’s a pretty shocking result,” says hydrologist Thomas Pagano of the U.S. Department of Agriculture’s Natural Resources Conservation Service in Portland, Oregon, who was not involved in the study. If the new results are widely applicable, “we’re treading water in terms of skill.” The answer, Pagano and others say, is for hydrologic forecasters to evaluate their past performance much more rigorously.

Grading past forecasts has long been standard practice in weather forecasting. Such forecast verification has shown that the introduction of Doppler radar in the early to mid-1990s really did lengthen warning times of tornados. Weather forecasters also compare proposed improvements in forecasting procedures against past performance before adopting them. Yet “little verification of hydrologic forecasts has been conducted to date,” says hydrologist Edwin Welles of the National Weather Service (NWS) in Silver Spring, Maryland.

So Welles—who has worked at NWS since 1994—tackled hydrologic verification in his 2005 dissertation for the University of Arizona. He considered NWS forecasts and observations of river levels during 10 years at 20 locations in Oklahoma and during 20 years at 11 locations along the mainstem of the Missouri River. On the Missouri, a forecast location had 500 to 1000 upstream basins feeding water to it. Each basin required its own set of calibrated predictive models, each predicting a different step in water flow, such as how much water was added by melting snow versus how much soaked into the ground.

In the April Bulletin of the American Meteorological Society (BAMS), Welles and colleagues report mixed results. Forecasters showed real skill in predicting river levels 1 and 2 days in advance compared with assuming that river levels would not change. But despite new models, more-powerful computers, better ways of displaying data and results, and even improved precipitation forecasts from NWS, the 1- and 2-day predictions didn’t become more accurate over the 1 or 2 decades of the verification study, at least in the two areas studied.

Troubleshooting hydrologic forecasting to understand why it’s been resisting improvement will take “objective study and well-structured verification,” says Welles, “not expert opinion or ad hoc experience.” BAMS