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Estimation of the uncertainty in water level forecasts at ungauged locations using Quantile Regression

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Water level predictions in rivers are used by operational managers to make water management decisions. Such decisions can concern water routing in times of drought, operation of weirs, and actions for flood protection, such as evacuation. Understanding the uncertainty in the predictions can help managers make better-informed decisions. Conditional Quantile Regression is a method that can be used to determine the uncertainty in forecasted water levels by providing an estimate of the probability density function of the error in the prediction conditional on the forecasted water level. To derive this relationship, a series of forecasts and errors in the forecasts (residuals) are required. Thus, conditional quantile regressions can be derived for locations where both observations and forecasts are available. However, 1D-hydraulic models that are used for operational forecasting produce forecasts at intermediate points where no measurements are available but for which predictive uncertainty estimates are also desired for decision making. The objective of our study is to test if interpolation methods can be used to adequately estimate conditional quantile regressions at these in-between locations. For this purpose, five years of hindcasts were used at seven stations along the IJssel River in the Netherlands. Residuals in water level hindcasts were interpolated at the five in-between lying stations. The interpolation was based solely on distance and the interpolated residuals were compared to the measured residuals at stations at the in-between locations. The resulting interpolated residuals estimated the measured residuals well, especially for longer lead times. Quantile regression was then carried out using the series of forecasts and interpolated residuals at the in-between stations. The interpolated quantile regressions were compared with regressions calibrated using the actual residuals at the in-between stations. Results show that even a simple interpolation based solely on distance provides good quantile estimates, making this method a promising option for estimating uncertainty in water level forecasts at locations without measurements. Practical considerations for implementing the method operationally will be discussed.