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Modelling and forecasting daily river discharge considering autoregressive heteroscedasticity

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When doing time series analysis, several sources of non-linearity can be present. One of these can manifest itself as heteroscedasticity, i.e. the non-constant conditional variance of the time series. In this case study it was investigated, whether this effect can be detected in selected in time series of daily discharges in Slovakia. Data measured in daily time step from the Hron and the Morava Rivers were considered.
To model heteroscedasticity, the GARCH (generalized autoregressive conditional heteroscedasticity) family of models was fitted to the time series. So far, only a few attempts to apply GARCH class models used on discharge data were reported in the hydrological modelling literature. The goal of investigation was to try to expand the knowledge in the time series modelling of hydrological time series with the aim to test the possibility to use the GARCH family of models on time series with daily time step and comparing forecasting performance with traditional ARMA models.
In order to achieve this, following steps were taken:
1. The presence of heteroscedasticity was tested in time series.
2. An ARMA type model combined with a GARCH model was fitted to the, comparing the fit with a fit of an ARMA model per se.
3. One – step – ahead forecasts from the fitted models were produced, performing comparisons to forecasts obtained by using only an ARMA class model on the same data.

The results show that heteroscedasticity was present in all of the tested time series. However, the GARCH model was applicable only in one case. The EGARCH(1,1) model had to be used otherwise. Here an interesting comparison to the financial time series can be made; unlike in econometric, where in general the so called leverage effect (i.e. the series reacts more strongly to negative changes) is present and pointed out by this model, here the data tends to react more strongly on positive changes. This is in accordance with the general property of hydrological processes, that the rise of discharge is rainfall driven (a highly nonlinear chaotic intermittent process) and the decrease of discharge is ruled by the damping effects of the water storage in the driven system (catchment or river reach. Even though the GARCH and EGARCH models did show improvements in the modelling and forecasting of flows, they still have several serious disadvantages (such as high sensitivity to the chosen fitting period) and possible further use should be further investigated.