



Change of runoff time scales during 20th Century due to landuse

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Recent research indicates that changes in watershed management practice can affect the discharge spectrum (periodicity) of river basins more than changes in climate and precipitation. Theoretical considerations show that decrease of water depth in stream networks caused by e.g. drainage works in agricultural areas would increase the steepness in the power spectrum of runoff. Wavelet analysis offers a natural choice for representation of non-stationary (drifting) statistics and is used for reference, but is difficult to relate to hydro-mechanical theory for the runoff process. Windowed Fourier spectra were used to represent gradual changes in runoff statistics during the snow free period of the year. An increase of the runoff spectrum was observed for daily discharge observations throughout the 20th century in a pronounced agricultural watershed in Sweden with an area of 953 km². For the same period, no trends were observed in the mean value of precipitation or its power spectrum. We find that the drift in spectrum is primarily linked to the periods shorter than 4 days, thus, indicating a successive change in the multi-fractal nature of the runoff spectrum. Since changes are linked to processes with time scales shorter than 4 days, it is likely that the underlying causes include morphological alterations of the stream hydraulics, like ditching and removal of stream pools. Corresponding, but weaker drifts of the runoff spectra were observed also in other watersheds with more pristine nature with size range of 241 – 3710 km², as well as a hydropower regulated river basin with a size of 25,058 km². The river regulation suddenly induced a drop of the spectrum slope for periods between 4 to 50 days, whereas the the increase in spectrum slope for shorter times is fairly consistent with the other rivers. The changes in runoff spectra can be explained by using the Fourier spectrum analysis, which can be linked to the kinematic wave theory for water surface flows. In the agricultural watershed there is a documented significant alteration in the landscape management during the 20th century including a gradual decrease in surface water area and volume.