Rainfall-induced groundwater level variation

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Abstract

The variation of groundwater level is a result of multi-effects including atmosphere pressure, earth tide, general diffusion, precipitation, earthquake and other irregular noises. For analyzing the rainfall-induced groundwater level variation, contributions on groundwater level from non-rainfall effects should be filtered out in advance. The BAYTAP-G model established by Japanese was used to remove barometric and tidal responses on groundwater level. The groundwater level that has been removed barometric and tidal responses is named the residual groundwater level in the present paper. Examining the data of residual groundwater levels, one could more easily to find the rainfall effect on the groundwater level variation. The groundwater levels of a sensitive well may rise sharply when rain starts falling in the watershed of the well. After rain stops, the groundwater level may exponentially drop to some level. Rainfall effect on the groundwater level could be divided into two parts: quick response and slow response. The quick rainfall response may remain few minutes to few hours, while the slow rainfall response may last few days or weeks.

This study takes the unit rainfall depth as an input time series and the quick rainfall response as an output series, and then to find the unit response function for the quick rainfall response on groundwater level via a linear system analysis, basing on the groundwater level data at Naba well station, Tainan, Taiwan. The base-flow separation methods, such as the smoothed minima technique and recursive digital filter method, were used to separate the quick and slow rainfall responses from groundwater level. The result shows that the recursive digital filter method with a filter parameter of 0.8 was suitable to separate the quick and slow responses from groundwater level at Naba well station. Fig.1 shows the comparison of the series of rainfall depth and its corresponding series of quick response on groundwater level. Fig. 2 shows an average unit response functions (Kernel function) of rainfall on groundwater level that was obtained via a linear system analysis, basing on the data of rainfall and groundwater levels during three periods. The unit response function sharply rise and up to a peak after about 2 hours, and then exponentially drop to some small value. The unit response function could be used to estimate the rainfall quick response on groundwater level once the rainfall data is given.

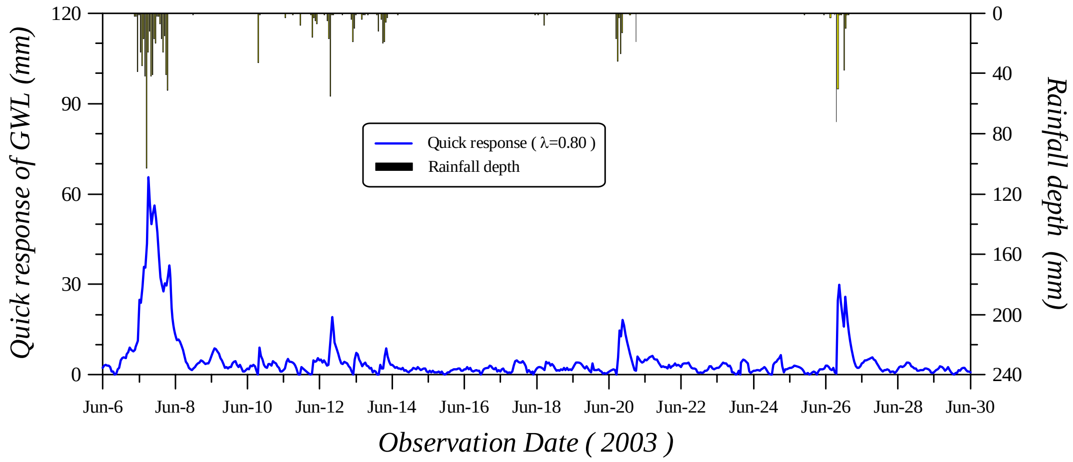

Fig. 1. A series rainfall depths and its corresponding quick response on groundwater level at the Naba well station.

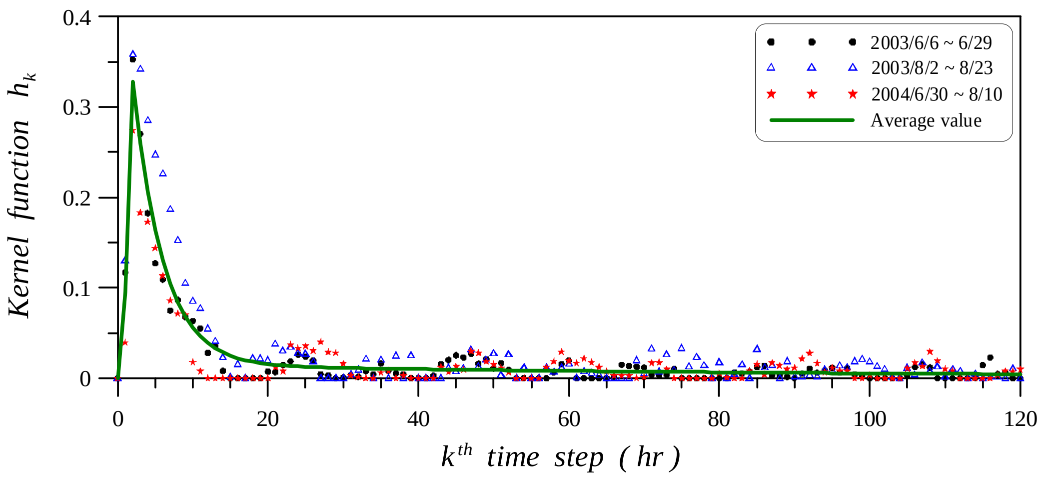

Fig. 2. Distributions of three discrete unit rainfall responses (Kernel functions) for three rainfall series, and the average unit rainfall response at the Naba well station.