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# Sensitive analysis of low-flow parameters using the hourly hydrological model for two mountainous basins in Japan

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Accurate estimation of low flow can contribute to better water resources management and also lead to more reliable evaluation of climate change impacts on water resources. In the early study, the nonlinearity of low flow related to the storage in the basin was suggested by Horton (1937) as the exponential function of $Q=KS^N$, where $Q$ is the discharge, $S$ is the storage, $K$ is a constant and $N$ is the exponent value. In the recent study by Ding (2011) showed the general storage-discharge equation of $Q = K^N S^N$. Since the constant $K$ is defined as the fractional recession constant and symbolized as *Au* by Ando *et al*. (1983), in this study, we rewrite this equation as $Qg=Au^N Sg^N$, where *Qg* is the groundwater runoff and *Sg* is the groundwater storage. Although this equation was applied to a short-term runoff event of less than 14 hours using the unit hydrograph method by Ding, it was not yet applied for a long-term runoff event including low flow more than 10 years.

This study performed a sensitive analysis of two parameters of the constant *Au* and exponent value $N$ by using the hourly hydrological model for two mountainous basins in Japan. The hourly hydrological model used in this study was presented by Fujimura *et al.* (2012), which comprise the Diskin-Nazimov infiltration model, groundwater recharge and groundwater runoff calculations, and a direct runoff component. The study basins are the Sameura Dam basin (SAME basin) (472 $km^2$) located in the western Japan which has variability of rainfall, and the Shirakawa Dam basin (SIRA basin) (205$km^2$) located in a region of heavy snowfall in the eastern Japan, that are different conditions of climate and geology. The period of available hourly data for the SAME basin is 20 years from 1 January 1991 to 31 December 2010, and for the SIRA basin is 10 years from 1 October 2003 to 30 September 2013.

In the sensitive analysis, we prepared 19900 sets of the two parameters of *Au* and $N$, the *Au* value ranges from 0.0001 to 0.0100 in steps of 0.0001 and the $N$ value ranges from 1.0 to 100.0 in steps of 0.5. The analysis was evaluated by the Average of Daily runoff Relative Error (*ADRE*). The results showed that the minimum value of the *ADRE* is 32.199% using $N$=100.0 and *Au*=0.0003 for the SAME basin, and is 38.058% using $N$=0.0003 and *Au*=70.0 for the SIRA basin. Log-log plot for optimal sets of *Au* and $N$ suggested accurate simulation of low flow can be achieved when relation of *Au* and $N$ are in exponential form. The equations are $Au=1/\{26.91N^{1.041}\}$ and $Au=1/\{34.55N^{1.060}\}$ for each basin, which have similar gradients, but have different intercept on the log-log graph. From this study, it is found that the optimal sets of *Au* and $N$, which obtained lower relative error in the hydrological analysis, are formulated using the exponent equation.

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