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Comparison of the characteristics of storm runoff and long-term discharge between a natural forest catchment and a complicated natural-artificial catchment in Japan

LIN HONG

State Key Laboratory of Water Resources and Hydropower Engineering Science, Wuhan University, China (Lhong@whu.edu.cn)

Agricultural activities such as land reclamation, crop production, pesticide and fertilizer application, irrigation and drainage will cause impact on the hydrological cycle and water quality of the catchment.

In this study, the hydrological characteristics during storm runoff and long-term discharges of a complicated natural-artificial terraced paddy field catchment, which is composed of natural forest (73% of the area) and terraced paddy field (27% of the area), are compared with those of a natural forest catchment.

According to the theory of the rational formula, peak discharge is given as:

$$Qp=fp\ r_{tp}A/3.6 \quad (1)$$

where, *Qp* is peak discharge, in m3/s; *fp* is the runoff coefficient, for the natural forest catchment and the complicated natural-artificial Catchment, *fp*=0.60 and 0.55, respectively; r_{tp} is the average intensity of actual rainfall during *tp*, in mm/h; *tp* is concentration time, in min; A is the area of the catchment, in km^2.

According to literature, *tp* is given as:

$$tp=CA0.22(r_e)\text{-}0.35 \quad (2)$$

where, C is a coefficient depending on land use, for the natural forest catchment and the complicated natural-artificial catchment and natural forest catchment, C=107 and 175, respectively; r_e is effective rainfall intensity and it is equal to the specific peak discharge of a storm, mm/h.

From the comprehensive effects of runoff coefficient and concentration time on peak discharge, we find that the peak discharge of the complicated natural-artificial catchment is about 1.5 times as much as that of the natural forest catchment.

Analyses of the recession limbs for various storms in the 2 catchments reveals that the storm runoff decreases with an exponential decay constant of 0.024 h^{-1} from several hours after rainfall to one or two days later, and then continues to decay with a decay constant of 0.011 h^{-1}.

By analysis of the relationship between percolation and duration of percolation in the 2 catchments we find that a linear relationship between the percolation and the duration of percolation exists, and the percolation rates of the complicated natural-artificial catchment are smaller than those of the natural forest catchment.

In this study, firstly 2 simple tank models of 4 layers are constructed to simulate the long-term runoffs of the 2 catchments. Because the simulation result of this model is not so much good (the relative error between calculated discharge and observed discharge of the complicated natural-artificial catchment during 1992-1994 is as high as 43.52 %), then we modify the lumped tank model into distributed tank model by incorporating the effects of the runoffs from the natural forest area (about 73 % of the land area) and the paddy field area (about 27 % of the land area) in the complicated natural-artificial catchment. Besides, we consider the differences of water management

in non-irrigation seasons and irrigation seasons in the complicated natural-artificial catchment by using different connections between the 2 subareas of the tank model for different periods. Moreover, we use hourly series of rainfall, evapotranspiration and discharge data instead of using daily ones in the distributed tank model considering that the complicated natural-artificial catchment area is small. With these modifications, the simulation result is improved (the relative error of the complicated natural-artificial catchment decreases to within 30 %).

Keywords: characteristic; natural forest catchment; a complicated natural-artificial catchment; storm runoff; long-term discharge; Tank model