Hydrological simulation in Tangnaihai and Lushi watersheds

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1. Introduction

Hydrological process of the Yellow River is very complex because it is affected by human activities very much. In order to understand the water circulation of the Yellow River basin and to examine some processes related to runoff formation change of the basin, a numerical model is necessary. In this issue, we will introduce a hydrological model system, in which some regional characteristics, like various land use and agricultural irrigation are considered, and report the result of the model application to the different scale watersheds of the basin, Tangnaihai and Lushi.

2. Model construct

A one-dimensional model (Figure 1) is set up based on Ma *et al*. (2000). The model is composed of three components: one-dimensional SVAT model, runoff formation model, and river routing model. The land use over the basin was lumped into five-group based on Matsuoka *et al.* (2005) dataset, namely, 1) Barren and urban, 2) Grass and shrub, 3) Forest, 4) Irrigated field and 5) Water. A brief summary of each component of the model is presented as follows:

SVAT model

The SVAT model is a simple biosphere model, in which the land surface includes a big-leaf and a soil layer. Using daily meteorological data, the model provides estimates of latent and sensible heat fluxes between the land surface and the atmosphere, and thermal regimes in the snow-cover and soil layer.

Parameters related to land use were determined according to the feature of vegetation. The irrigation period is designed from the climate and the kinds of farm product.

Runoff model

A conceptual model HYCY (Fukushima, 1988) is used to determine the formation of runoff for a regional scale watershed. There is a reservoir system representing each of the four runoff components, which are saturated land surface runoff, infiltration runoff from the topsoil zone, base runoff and direct runoff from the water surface.

River routing model

To estimate river flow from upper stream to downstream, a lineal model is used. The velocity of river flow is set as a constant.

The model was applied to the Tangnaihai watershed (120,000 km^2 in area, over 3,000 m in a.s.l.), a source area of the basin from 1980-2001, and Lushi watershed (4,600 km^2 in area, 900-2,000 m in a.s.l.), a source area of Luohe, a tributary river in midstream in the period 1980-2000 (see Figure 2). As model input, 117 meteorological station data was used.

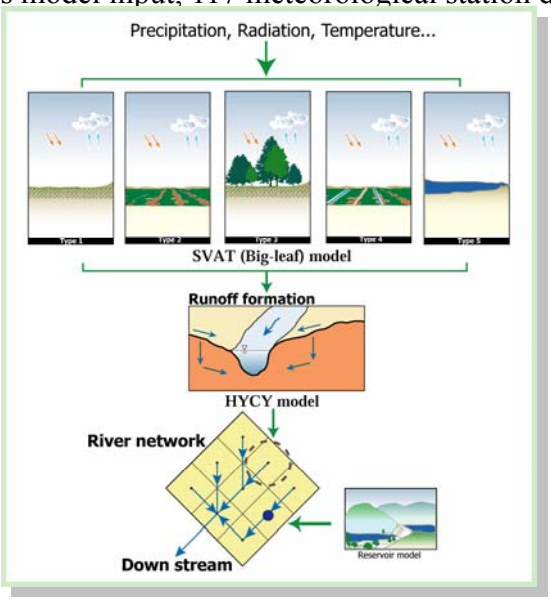

Figure 1 Hydrological model system.

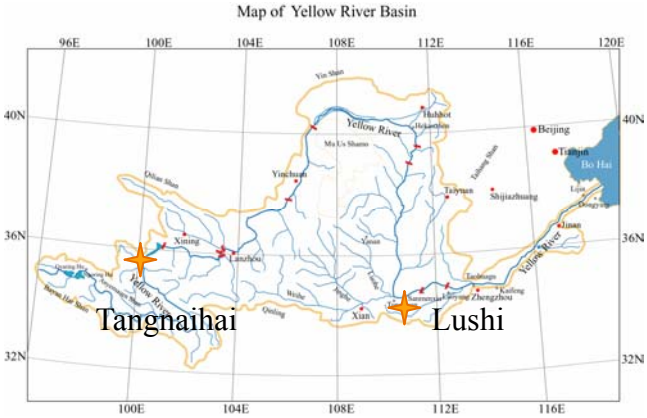

Figure 2 Location of two watersheds.

3. Results

Figure 3 shows the monthly hydrograph at Tangnaihai gauge. The simulated discharge is in agreement with observed one very well through 18-year. Annual runoff error between simulation and observation is shown in Figure 4. It is 1.8 mm in average and about 1% of the annual runoff average.

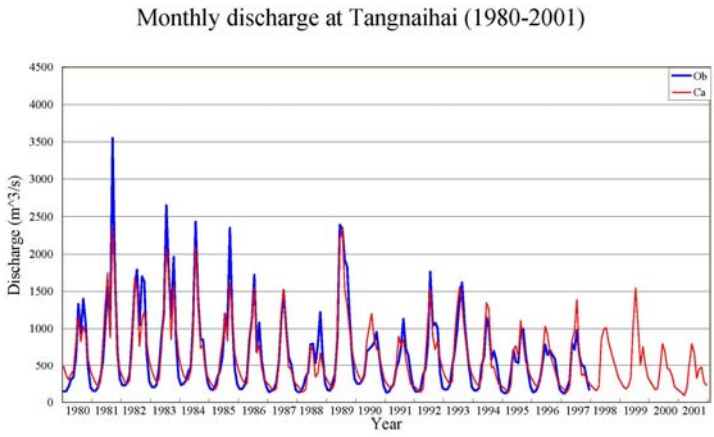

Figure 3 Monthly discharge at Tangnaihai gauge from 1980 to 2001.

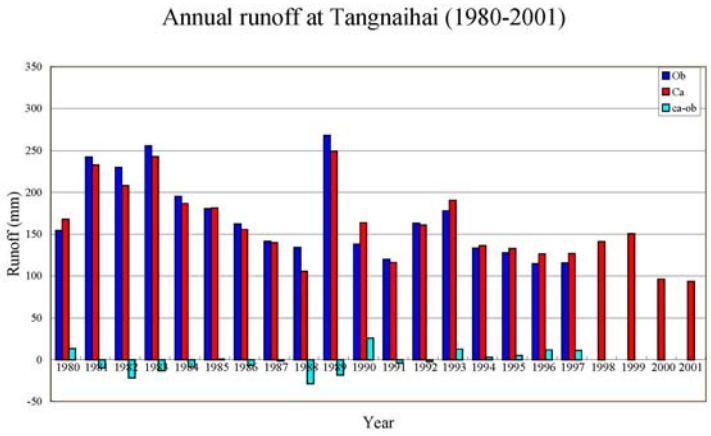

Figure 4 Annual runoff and its error between simulation and observation at Tangnaihai gauge from 1980 to 2001.

Monthly discharge and annual runoff at Lushi gauge are shown in Figure 5 and 6. The seasonal variation could be represented expect with extreme drought years, like 1986 and 1997. The error of annual runoff between simulation and observation is small, 3.4 mm in average and about 1.5 % of the annual runoff average.

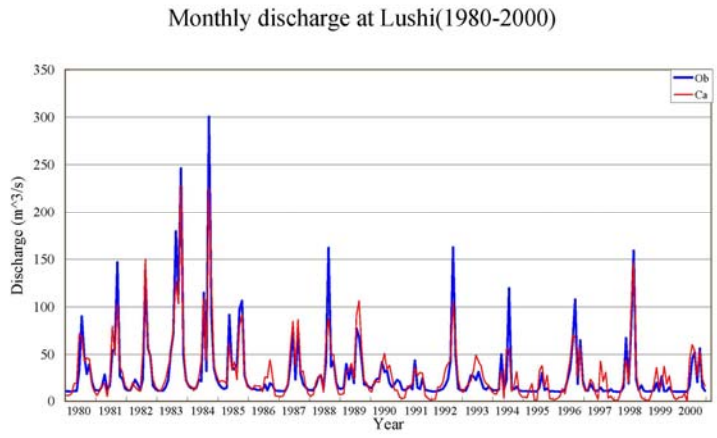

Figure 5 Monthly discharge at Lushi gauge from 1980 to 2000.

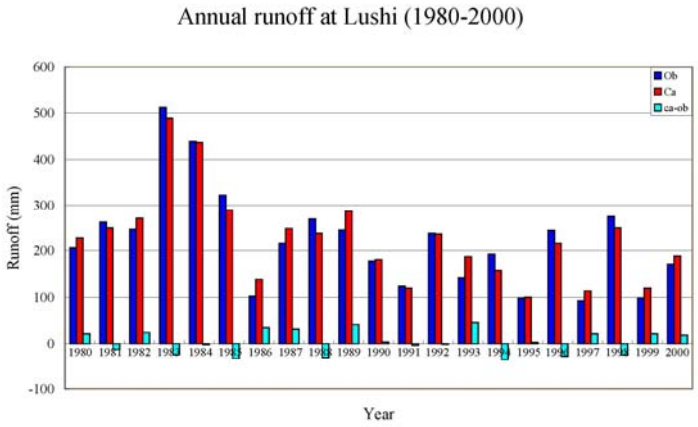

Figure 6 Annual runoff and its error between simulation and observation at Lushi gauge from 1980 to 2000.

4. Conclusions

A model system for the Yellow River study was constructed. The model system performance has been confirmed at Tangnaihai and Lushi watersheds of the Yellow River basin. Although the size and climate condition of two watersheds are very different, the seasonal variation of discharge and total annual runoff could be represented well. It is suggested to succeed in the estimation of each item concerning the water budget. In other words, the constructed model is very appropriate. In order to understand the water cycle change of the Yellow River, a hydrological simulation of the whole basin will be done using the model system in the future.

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