Abstract

Evapotranspiration is the second largest quantity in the water cycle and an important indicator for climate changes. Accurate estimations and better understanding of evapotranspiration are required in hydrologic studies and water resources modelling under stationary and changing climate conditions. Under the background of global warming and climate change over the last 50 years in China, what was the change in evapotranspiration? How the change has impacted on the water cycle? To address these questions effectively, this thesis focuses on the study of potential evapotranspiration and actual evapotranspiration over China.

This study begins with a comparison between the estimates for potential evapotranspiration using the Penman-Monteith and the Thornthwaite methods as well as the pan data. The Penman-Monteith method is considered as the most physical and reliable method, while the Thornthwaite method is the most practical and widely used method. The comparison focuses on the usefulness of the Thornthwaite estimates, which can guide the use of this simple method in China. In the second stage of the study, the seasonal and annual potential evapotranspiration estimated by the Penman-Monteith method for China as a whole and for the major basins are investigated. Then, the modified Thornthwaite water balance model is used to examine the regional and country scale changing properties of actual evapotranspiration over China during 1960-2002. Finally, a detailed investigation of the regional actual evapotranspiration estimated by using the Thornthwaite water balance method and the two complementary relationship methods (advection aridity (AA) model and Granger and Gray (GG) model) is performed in the Haihe River basin in northern China.

The results show that the Thornthwaite estimates result in different regional patterns and temporal trends, while the pan measurements display a consistent regional pattern and similar trends as compared with that of Penman-Monteith estimates. Overall, the pan measurements are more useful than the Thornthwaite estimates if appropriate pan coefficients are determined. The declining trends in potential evapotranspiration in most part of China during 1956-2000 are detected except for the Songhua River basin in Northeastern China where an insignificant increasing trend is found. Generally, declining trends of sunshine duration and/or wind speed at the same period appear to be the major causes for the negative trend of the potential evapotranspiration in most areas. The annual actual evapotranspiration had a decreasing trend during 1960-2002 in most areas east of 100ºE and there was an increasing trend in the west and the north parts of Northeast China. In the humid southeast part of China, the spatial distribution of the temporal trend for the actual evapotranspiration is similar to and dominated by that of the potential evapotranspiration. But in the arid northwest region, the trend in precipitation controlled the long-term changes of the annual actual evapotranspiration. In the other regions, the combined effects of the changes in precipitation and potential evapotranspiration played a key role.

Keywords: Potential evapotranspiration, Actual evapotranspiration, Spatial and temporal characteristic, Trend, Controlling factors, Water cycle, Thornthwaite water balance, China