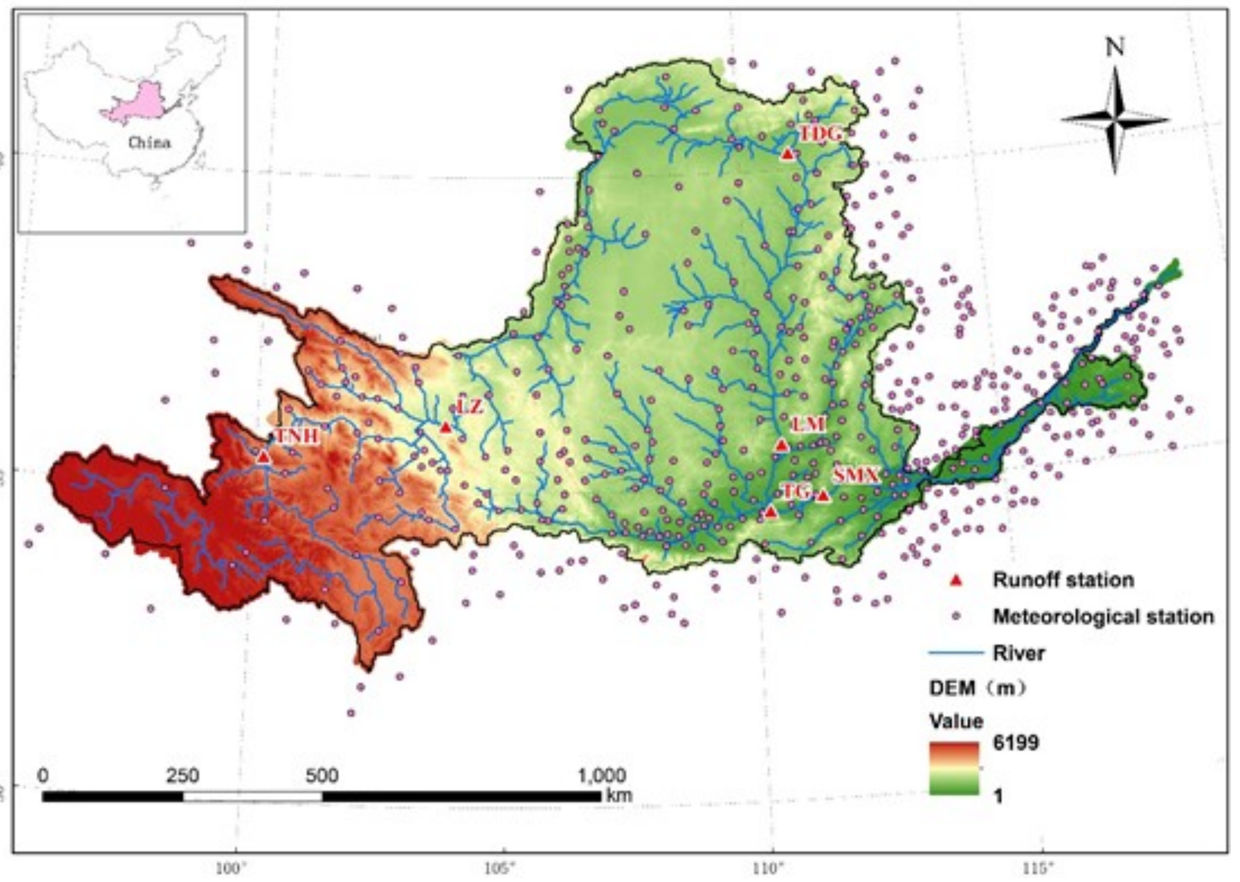
ENSEMBLE PROJECTION OF RUNOFF FOR THE NEXT 30-50 YEARS IN THE YELLOW RIVER BASIN WITH BMA APPROACH

22nd IAHR-APD CONGRESS 2020 IN SAPPORO

Ziqi Yan, Zuhao Zhou, Jiajia Liu (State Key Laboratory of Simulation and Regulation of a Water Cycle in a River Basin, China Institute of Water Resources and Hydropower Research, China)

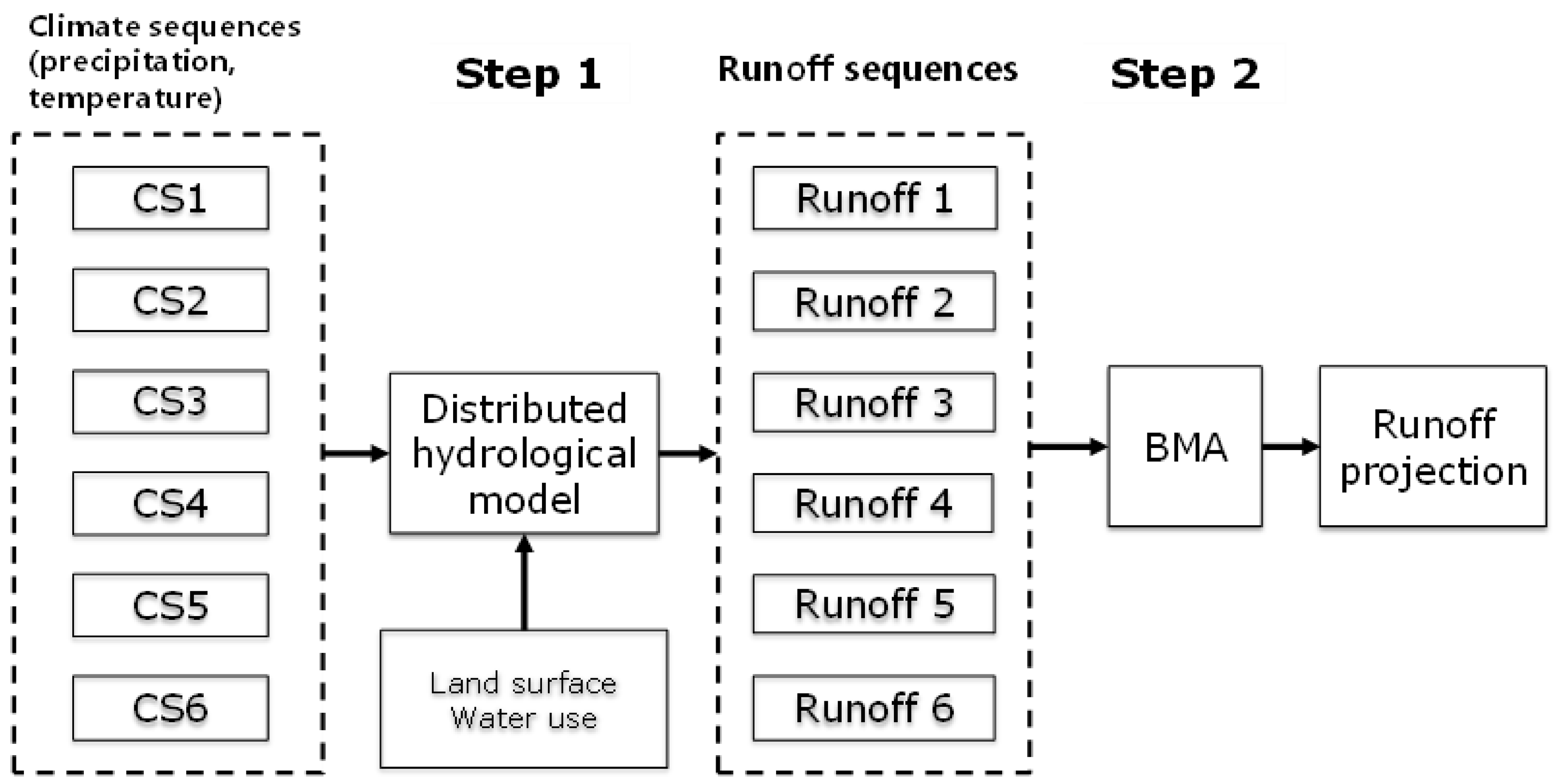
Introduction

To project the runoff of a large-scale basin under climate change and human activity, this study aimed to establish an ensemble projection method, which consists of climate and hydrological models; uncertainty analysis is also a focal point. BMA approach was applied for large-scale basins. The method is demonstrated using the Yellow River Basin, which is a typical large basin in China.



Methodology

- An ensemble projection framework was designed to project the future runoff of large basins.
- The second step is to use a global BMA approach to produce a weighted average ensemble projection based on multiple runoff results.



Let Q be the projected value, D =[X, Y] be the input data (X and Y are the simulated runoff data and observed runoff data, respectively), and f =[$f_1, f_2, \ldots, f_k$] be projected runoff values generated by a K number of models. Thus, the BMA probability project can be expressed as follows:

$$E[Q|D] = \sum_{k=1}^{K} p(f_k|D) \cdot E[g(Q|f_k, \sigma_k^2)] = \sum_{k=1}^{K} w_k f_k$$

Results

Table 2 Ensemble projection of annual average runoff (Billion m^3)

Section	Reference period	2050 (2041–2060)		2070 (2061–2080)	
		Runoff	90% confidence interval	Runoff	90% confidence interval
Tangnaihai	20.1	17.7	[13.3, 20.8]	17.2	[12.9, 21.2]
Lanzhou	31.7	28.5	[22.3, 33.1]	27.8	[21.7, 33.4]
Toudaoguai	30.4	27.9	[21.5, 32.4]	27.3	[21.2, 32.7]
Longmen	34.1	31.1	[23.6, 35.8]	31.2	[23.8, 38.2]
Tongguan	41.9	37.9	[27.5, 45.5]	39.2	[26.7, 48.9]
Sanmenxia	42.2	38.2	[27.7, 45.9]	39.5	[26.8, 49.3]

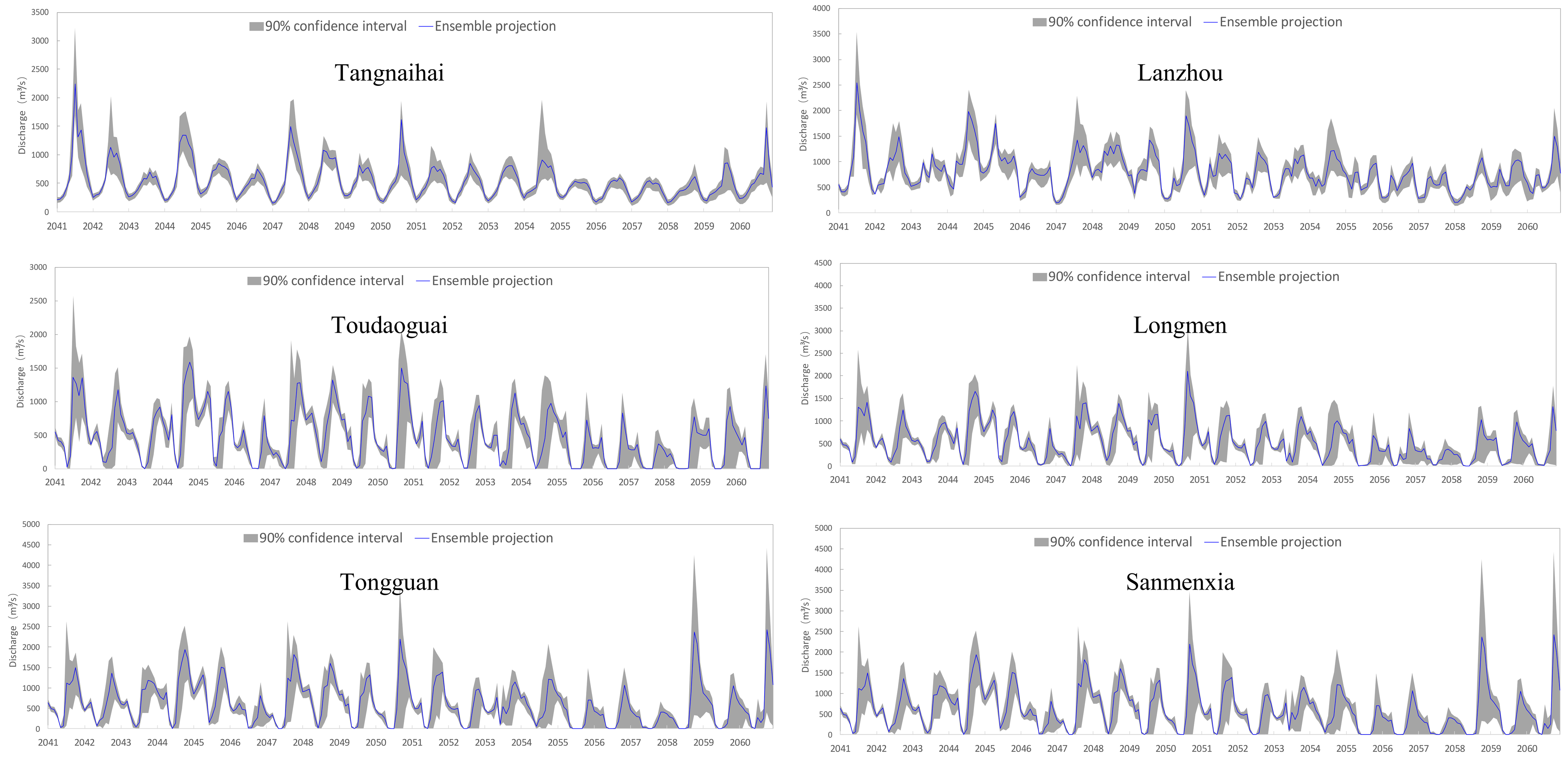


Figure 3a Ensemble projection of discharge (m^3/s) in the 2050 period

In the 2050 period, the annual average runoff values for the six main sections (i.e., Tangnaihai, Lanzhou, Toudaoguai, Longmen, Tongguan, and Sanmenxia) are 17.7, 28.5, 27.9, 31.1, 37.9, and 38.2 billion m^3, respectively. In the 2070 period, the annual average runoff values for the six main sections are 17.2, 27.8, 27.3, 31.2, 39.2, and 39.5 billion m^3.

Conclusion

(1) A general ensemble projection framework for future hydrological conditions was established.
(2) Runoff in the 2050 and 2070 periods in the upper and middle reaches of the Yellow River Basin decreases by 4.0 billion m^3 and 2.7 billion m^3.
(3) It is more difficult to simulate the middle and lower reaches of the Yellow River Basin, and the results have more uncertainty.

References

- Ajami, N. K., et al., 2006. Journal of Hydrometeorology
- Jia, Y.W. et al., 2006. Journal of Hydrology
- Zhou, W.C., Han, Z.Y., 2018. Journal of Meteorology and Environment