Evaluation of Interpolating Methods for Daily Precipitation at Various Gauge Densities

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1. Motivation & Objectives

Motivation: Evaluations and comparisons of spatial interpolating methods in precipitation have been well studied. But no optimal method has been concluded, since comparisons did not involve analysis of gauges density.

Objectives:

1. to assess interpolating methods at various density scenarios;
2. to examine sensitivity of interpolating methods to gauge density;

2. Methodology

Four equidistant projections (a cylindrical, an azimuthally, a conic and two-point equidistant projection (TPE)) and geographic system (GS) were compared. TPE was selected since the distances between any points were the most similar with the great circle distances. We compared five methods (Nalder, 1998).

1. Nearest Neighbor (NN);
2. Ordinary Kriging (OK);
3. Simple Kriging (SK);
4. Inverse Distance Squared (IDS);
5. Gradient–plus IDS (GIDS);

Parameters of these methods were identified by Genetic algorithm. GIDS based on GS and TPE was compared.

3. Study area & Data

Xiangjiang Basin, with an area of 94,660 km^2, is the largest tributary of Dongting Lake (Fig.1). The climate is tropical monsoon climate with annual precipitation of 1458mm. The daily precipitation data is from 2000 to 2005. Seven gauge density scenarios, i.e. 30, 60, 90, 120, 150, 180, 210 gauges were randomly built.

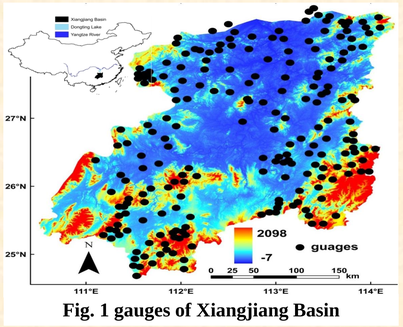

Fig. 1 gauges of Xiangjiang Basin

4. Results

1. OK ranked the first, and then SK, IDS, GIDS (GS) and GIDS (TPE) (Fig.2&3). Mean error, root mean squared error and index of agreement showed the similar results, not shown for clarity.
2. The relation between average NSE of NN, OK and SK and number of gauges shared the same equation: y=a*exp(b*x) +c*exp(d*x) (Fig.3).

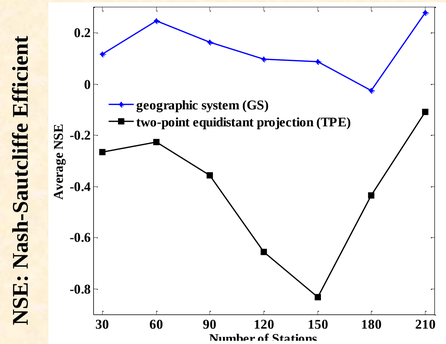

Fig.2 Performances of two GIDS

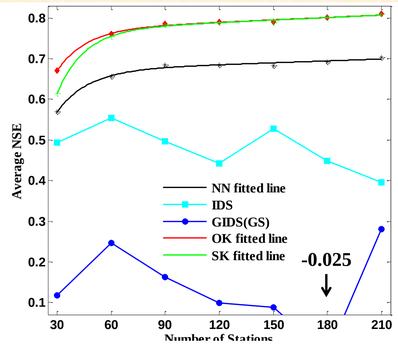

Fig. 3 Comparision of five methods

3. NN performed better with the increasing gauge densitiy in precipitaion quantilies of 50% ~ 95%, and OK and SK in 25% ~ 95% (Table 1).

Table 1 Root Mean Squared Error of NN, IDS, OK, SK in the selected quantilies

	Maximum (394mm)				50% (16.1mm)				95% (0.1mm)			
No.	NN	IDS	OK	SK	NN	IDS	OK	SK	NN	IDS	OK	SK
30	23.9	69.4	24.6	24.4	2.21	2.18	2.36	2.30	0.00	.000	.000	.253
60	41.1	41.7	29.7	29.7	1.63	2.27	1.62	1.62	.018	.013	.014	.258
90	41.2	49.1	28.5	28.6	1.40	2.15	1.30	1.31	.015	.011	.012	.123
120	32.2	66.5	25.7	25.6	1.52	2.27	1.25	1.27	.013	.009	.010	.083
150	29.6	44.3	23.6	23.6	1.48	2.30	1.24	1.25	.014	.008	.009	.124
180	36.1	62.0	31.0	30.9	1.65	2.59	1.28	1.28	.011	.007	.008	.044
210	30.0	59.5	28.7	28.7	1.58	2.92	1.22	1.23	.010	.007	.007	.057

5. Conclusions

In this research, four criteria were used to assessment five interpolating methods at seven scenarios in Xiangjiang Basin. Performances of these methods and their sensitivities to gauge density were analyzed.

1. GIDS based on GS was better than that based on TPE. Compared with other methods, GIDS was not suitable for daily precipitation.
2. Performances of NN, OK and SK methods based on average NSE shared the same general equation, showing significant increase when less than 90 gauges were used. Performances of IDS was not related to gauge density.
3. NN, SK, OK and IDS did not perform better with the increasing gauge density for high precipitation. This meant that the improvement of average NSE with the increasing gauge density was due to better estimations in low precipitation by these methods.
4. OK and SK are high valued. However, they are very complex and time-consuming. Hence NN is recommended in limited conditions.

Reference: Nalder, I., Wein, R., 1998. Spatial interpolation of climatic normals: test of a new method in the Canadian boreal forest. Agricultural and Forest Meteorology, 92(4): 211-225.

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