Study on the Mapping of Rainfall Contour in Pu'er, Yunnan

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Abstract: This paper briefly introduces the development of GIS and its application in hydrologic analysis. The paper interpolates the predicted rainfall of pu'er city in 2017 and draws the rainfall contour line by using kriging method, inverse distance weight method, obstacle spline function and geostatistics kriging method in the deterministic interpolation method. The results show that the interpolation results are of high accuracy and the interpolation errors are ranked from small to large as inverse distance weight interpolation < including obstacles interpolation < kriging interpolation. The inverse distance interpolation method can be used to draw the rainfall contour map of pu'er city.

1. Introduction
In the early 1960s, the CGIS system developed by Dr. Roger Tomlinson in Canada was regarded as the world's first truly applied geographic information system. It was mainly used to analyze the capability of rural land in Canada. But its development complexity was not widely used. In the early 1980s, Esri's ARC/INFO 1.0 marked the birth of the first commercially available GIS software. In China, a method for calculating the areal rainfall in Wenchuan earthquake area was established based on ArcGIS, which provided hydrometeorological technical support for emergency decision-making service[1]. Arc Hydro Tool was used to extract the characteristics of the Dianchi lakebasin which could improve the efficiency of hydrological model establishment. Arc Hydro Tool can promote flood monitoring and prevention. Meanwhile, it greatly reduces the acquisition cost of source data[2]. ArcCIS Hydro Tools is also used in hydrologic analysis. The results show that the calculation accuracy can meet the requirements of the reservoir capacity calculation of barrier lake. This method has low cost of data acquisition and fast calculation speed which plays an important role in the emergency hydrologic analysis and risk disposal of barrier lake[3]. Some researchers believed that the precision of rainfall interpolation based on GIS technology can meet the requirements[4][5]. This paper introduces the application of ArcGIS in hydrologic analysis. Puer city is taken as the research area to draw the rainfall contour line in the basin under the ArcGIS platform and the rainfall contour line drawing model is established.

2. Digital elevation model (DEM)
DEM(Digital Elevation Mode) is an important original data source for the identification of watershed topography and features[6]. It is an important data source for the extraction of hydrological elements such as watershed water system,geomorphic features. Also, DEM is important data source to
established of hydrological models for hydrological analysis. The corresponding DEM data can be obtained free of charge through the geoscience data cloud of the Chinese academy of sciences.

3. Application of ArcGIS in hydrologic analysis
ArcGIS space has strong processing capacity in hydrology and water resources in hydrological analysis which has the advantages of low cost, high efficiency, visualization. The hydrological analysis in ArcGIS is mainly calculated by the algorithm proposed by Jensen and Dominique (1988) [7], as shown in Figure 1.

![Flow analysis](image1)

**Figure1.** Calculation process of hydrologic analysis

4. Draw rainfall contour

4.1 Data of rainfall sites
Rainfall forecast of pu'er city in 2017 is shown in Figure 2. The method of modifying rainfall value can be directly modified by property sheet or the new rainfall value can be added and modified by connecting property sheet.

![Precipitation/mm](image2)

**Figure2.** Rainfall in represents precipitation of Pu'er

4.2 Rainfall contour lines
The region of 2017 rainfall trend prediction 40 main precipitation station on behalf of the site to predict rainfall interpolation analysis by the kriging interpolation method, inverse distance weighting method, obstacle spline function and statistical kriging method. It is using the mask of spatial analysis to extract tool extraction with pu'er city as the study area boundary of interpolation results for application of surface analysis tool to generate rainfall isoline. The results are shown in Figure 3.
4.3 Analysis of interpolation results

In order to test the accuracy of different interpolation methods and compare the advantages and disadvantages, it was randomly selected 6 stations (15%) for testing this paper. Each interpolation method has a high interpolation accuracy and the error after comparison is ranked from small to large as inverse distance weight interpolation < interpolation with obstacles < kriging interpolation as can be seen from table 2. The geostatistical interpolation with spatial topographic factors is better. In terms of the effect, the contour line drawn by interpolation results of inverse distance weight and spline function with obstacles is smooth and beautiful which is better than the other two interpolation methods. In general, the inverse distance interpolation method can be used to draw rainfall contour map.

Table.1 comparison of precipitation obtained by different interpolation methods with actual values

| Test site   | Serial number | The actual value | Deterministic spatial interpolation method | Geostatistical method |
|-------------|---------------|------------------|--------------------------------------------|-----------------------|
|             |               |                  | Inverse distance interpolation | Kriging interpolation | Interpolation with obstacles | Kriging interpolation |
| Jing Dong   | 1             | 1174.10          | 1174.45 | 1368.57 | 1174.10 | 1185.52 |
| Meng Da     | 2             | 1618.00          | 1617.99 | 1490.98 | 1618.00 | 1621.08 |
| Si Mao      | 3             | 1563.50          | 1564.77 | 1653.13 | 1554.41 | 1576.81 |
| Meng Lang   | 4             | 1700.20          | 1700.09 | 1699.03 | 1700.20 | 1697.19 |
| Ma San      | 5             | 3719.00          | 3708.08 | 2269.18 | 3716.17 | 3567.41 |
| Qi Yi bridge| 6             | 1701.40          | 1702.48 | 1954.37 | 1722.13 | 1718.13 |
| Mean absolute error | 2.29    | 352.51  | 5.44   | 33.19  |
| Mean relative error       | 0.001  | 0.140    | 0.003  | 0.012  |
| Mean square error          | 4.51   | 609.37   | 9.31   | 62.70  |

5. Model

The Model Builder is used to create the rainfall contour drawing Model. After the Model is established and saved, then directly click to select parameters to draw the contour which is simple and effective. This paper only lists the establishment of the model based on the interpolation method of spline function with obstacles. The basic components of the model are shown in Figure 4 and the running results of the model are shown in Figure 3 (c).
6. Conclusion
1) ArcGIS is powerful in spatial processing and analysis. The interpolation errors of each interpolation method in this paper are ranked from small to large as inverse distance weight interpolation < interpolation including obstacles < kriging interpolation. Secondly, the geostatistical method considering spatial topographic factors has better interpolation effect.

2) The effect of the contour line drawn by interpolation between the inverse distance weight and the spline function containing obstacles is better than the other two interpolation methods. In general, the inverse distance interpolation method can be used to draw rainfall contour map.

3) It is established corresponding interpolation model can simplify interpolation steps and improve work efficiency.

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