A new method for the forecasting of Spatial Distribution of Precipitation and Temperature in Gharehsoo River Watershed

Kazem Javan[1], Hamid TaheriShahraiyni[2*], Farzin NasiriSaleh[3], Majid HabibiNokhandan[4]

1. MSC Student in Civil Engineering, Water Engineering, Faculty of Civil and Environmental Engineering, TarbiatModares University.
2. PhD in Civil Engineering- Water Engineering, Assistant Professor, Faculty of Civil and Environmental Engineering, TarbiatModares University
3. PhD in Civil Engineering- Water Engineering, Assistant Professor, Faculty of Civil and Environmental Engineering, TarbiatModares University.
4. PHD in Climatology, Assistant Professor, Institute of Climatology, Mashad.

Archive of SID

Introduction

Precipitation and temperature patterns have especial role in the accuracy of hydrologic models. future patterns of rainfall and temperature can lead to better hydrological predictions. Hence, according to their importance, we try to derive the future rain and temperature patterns of the Gharehsoo River's watershed.

This watershed is in the northwest of Iran in the Ardebil province and it has high amount of agriculture productions. Interpolation schemes are utilized in this study to determine rain and temperature patterns. The utilized software package is ArcGIS software.

These interpolation techniques include Inverse Distance Weighting (IDW), Global polynomial, Local polynomial, Radial Basis Functions (RBF), ordinary Kriging and simple Kriging. Firstly, we obtained data of monthly temperature and precipitation for 10 synoptic stations in 2004.

Then, the interpolation schemes were evaluated in order to determine the best temperature and precipitation pattern. The evaluation criteria in this study were Root Mean Square Error (RMSE) and Mean Error (ME). The results of evaluations for different interpolation schemes demonstrated that IDW and RBF methods are the best schemes for the spatial modeling of temperature and precipitation patterns, respectively.

Using these patterns, it is straightforward to predict runoff using hydrological models. In this paper, a new algorithm is proposed to predict temperature and precipitation patterns in future (2100).

To predict temperature and precipitation patterns, it is necessary to utilize a predictor model to predict the

* Corresponding Author: +98-09124457966 Email: hamid.taheri@modares.ac.ir

www.SID.ir

amount of precipitation and temperature.

Then the amount of precipitation and temperature are converted to spatial pattern of precipitation and temperature using the developed algorithm in this study. PRECIS model that is a regional climate model was utilized as predictor model in this study.

Materials and methods

a) case study: The studied area (Gharehsoo river watershed) is located in the Northwest of Iran, between longitudes coordinates 47°45' and 48°42' E, and between latitudes 37°46' N and 38°34' N. The Gharehsoo river watershed area is approximately 4100 km^2 and plays a significant role in agricultural production in Iran. The mountainous areas are in the western and south-eastern parts of watershed. Furthermore, there are many pasture and agriculture lands in this watershed. The watershed elevation varies from 1170m in Gharehsoo river outflow to 4732m in Sabalan mountainous. The precipitation in the watershed is highly related to the topography and wind regime in the watershed.. The sea fronts and orographic conditions are the main factors for precipitation in the western and eastern parts of watershed. In the winter, the cold front of Mediterranean Sea, coupled with the local effects of Sabalan Mountains lead to orographic rainfalls. In summer, weather conditions of predominant Caspian Sea front are the major factor for precipitation in eastern part of the catchment. Autumn and spring rainfalls are mainly due to the interactions between African-Mediterranean and Caspian Sea fronts.

b) Data: Temperature and precipitation data are two basic climate variables, measured at meteorological stations. Monthly precipitation (mm) and temperature data for 2004 were obtained from Iran Meteorological Organization. The number of stations in the watershed and near to watershed was 11 stations.

c) PRECIS Model

PRECIS (Providing Regional Climates for Impacts Studies) is a regional modeling system and can be run over any scale in an area of the globe on a relatively inexpensive fast PC to provide regional climate information.. The idea of constructing a flexible regional modeling system originated from the growing demand of many countries for regional-scale climate projections. Only a few modeling centers in the world have been developed RCMs (Regional Climate Models) and utilize them to generate projections over specific areas, because it needs high amount of computational effort and time. The Hadley Centre has configured the third-generation of Hadley Centre RCM, named PRECIS that is easy to set up. The past (1961-1990) and

Archive of SID

www.SID.ir

future climate SRES B2 scenario (2071-2100) were simulated by PRECIS model at a spatial resolution of 50×50 km over Iran.

Results and discussion

It's necessary to have a series of precipitation and temperature patterns to produce monthly patterns for future. In this study, these series of maps are generated using the precipitation and temperature patterns of 2004. The hyetograph maps are calculated by the ration of total volume of precipitation in January and the area of watershed. The calculated total volume of precipitation in January using the precipitation pattern map was about 490 million m^3. The ration of volume and the area of watershed was about 0.117 m. This number shows the average precipitation of January. Similarly, these operations can be performed for the other months of 2004. The unit hyetograph and thermograph maps are generated by dividing the precipitation and temperature patterns in 2004 to their corresponding monthly precipitation and temperature values. The precipitation and temperature data were extracted from the PRECIS model for 2100. The monthly temperature data of 2100 shows an increase of temperature about 2 to 5 degrees in future, but there is no specific trend in precipitation data. If the amount of the monthly temperature and precipitation of 2100 are divided by these amounts in 2004, the amount of B parameters are calculated for precipitation and temperature in different months. Finally, the precipitation and temperature patterns will be obtained by the product value of B parameters and unit hyetograph or thermograph maps in each month, respectively.

Conclusion

A new method was developed for reasonable prediction of spatial patterns of precipitation and temperature. This method uses the results of a Regional Climate Model (PRECIS model) coupled with the appropriate spatial modeling techniques (interpolation techniques). The derived precipitation and temperature patterns in 2100 in Gharehsoo River watershed show a reasonable similarity with the topography and the climate of the region, Hence This method can be introduced as an appropriate method for the hydrological forecasts and water resource management.

Keywords: prediction, spatial distribution of precipitation, spatial distribution of temperature, Gharesoo river watershed, PRECIS, interpolation techniques

Archive of SID

www.SID.ir