Estimation of Snow Characteristics by Wavelet and Geostatistic Methods (Case Study: North-West Basins)

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Received: 10/06/2016 Accepted: 04/02/2017

Extended Abstract

Introduction

Snow is an important hydrological phenomenon and snow water equivalent is suitable water resource in many parts of the world. Snow and snow water equivalent have a significant contribution in streamflow and groundwater recharge. For this reason, it is important modeling of snow accumulation and melting. So, estimation of snow spatial distribution in different time scales is one of the key stages in the studies of water resources.

Due to the successful application of wavelet network model method in different sciences, the purpose of this study is to estimate the snow characteristics. In this study, the spatial analysis of snow water equivalent, snow depth and snow density, as one of major components of the water balance, is evaluated in watershed of the north-west country.

Materials and methods

In this study, we have used geostatistical methods to estimate spatial distribution of snow height, snow density and snow water equivalent. Thus, by measurement data of three provinces of Azabbayjan- Sharghi, Azarbayjan- Gharbi and Ardebil during four years (2008-2012) in north-west, we have also evaluated capability of Artificial Neural Network, Wavelet model (Wavelet-ANN) and geostatistical methods. Figure 1 shows location of study area and the data.

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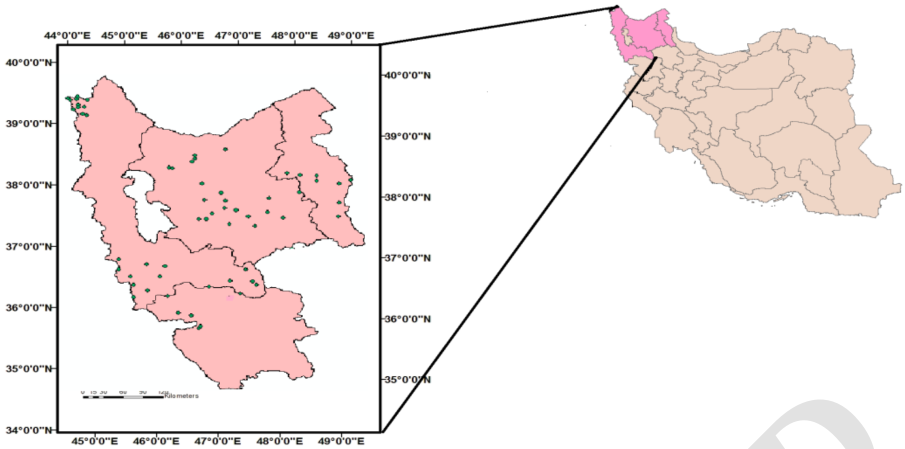

Figure 1. Location of study area

For estimation of snow characteristics in non-measurement estimated points, we have used the evaluation by longitude and latitude parameters. The results the comparison between each geostatistical methods has been conducted by the Normal Root Mean Square Error (NRMSE) index.

$$NRMSE = \frac{\sqrt{\frac{\sum_{i=1}^{n}(X_i - Y_i)^2}{n}}}{\bar{Y}} \quad (1)$$

Where X_i ,Y_i: i^{th} are estimated snow data, n: number examples. The drawing of zoning maps has been carried out by ArcGIS.

Results and discussion

Before zoning, correlation coefficient values of snow density, snow height and snow water equivalent as dependent geographic properties has been obtained in SPSS (Table 1).

Table 1. The correlation coefficient matrix of used variables

Snow height	Snow water equivalent	Snow density	Elevation	Latitude	Longitude	
0.218	0.270*	0.167	0.276*	-0.456**	1	Longitude
-0.103	-0.107	-0.053	0.105	1	-0.456**	Latitude
0.500**	0.489**	0.221	1	0.105	0.276*	Elevation
0.035	0.410**	1	0.221	-0.053	0.167	Snow density
0.893**	1	0.410**	0.489**	-0.107	0.270*	Snow water equivalent
1	0.893**	0.035	0.500**	-0.103	0.218	Snow height

In addition to Table 2, elevation and longitude with correlation coefficients of 0.489 and 0.270, respectively, have the most effect on snow water equivalent. The positive sign indicates straight relative relation of elevation and longitude with snow water equivalent.

As a general result, each three snow characteristics have positive relationship with elevation. It is because the elevation is an important topography factor and increase in height leads to decreased air temperature and enhancement of snow.

The results indicated that the Ordinary Kriging method with Gaussian semi-variogram have had the best results than all other geostatistical methods. The results have indicated that mean accurate kriging method with Guassian semi variogram for snow density, snow water equivalent and snow height during four years based on Normal Root Mean Square Error (NRMSE) are 0.259, 0.429 and 0.390, respectively. The results of application modeling of Wavelet-ANN have indicated that the NRMSE values for snow density, snow water equivalent and snow height are 0.122, 0.002 and 0.001, respectively. Therefore, it can be said that accuracy of Wavelet-ANN method in estimation of snow characteristics is more than geostatistical methods. Also, the accuracy of both methods in simulation of snow height is the most. Another results illustrated that with applying Wavelet-ANN, difference between minimum and maximum values of snow characteristics is decreased.

Conclusion

The purpose of this research is to develop interpolation methods to assess the estimation of snow components in the non-measurement points. In addition to equipment and preparation problems of snow stations, it is necessary to use modern methods to estimate the snow spatial distribution. The results of this study have also indicated that in the study area and in a four years period, ordinary kriging has given better results than other geostatistical methods. But, the difference in the results of geostatistical methods with Wavelet-ANN in estimation of snow characteristics is high. Applying wavelet-ANN method has decreased error values. Thus, it is recommended to use Wavelet-ANN method in estimation of snow characteristics of study area. Since the used independent variables are located in available variable categories (access to the data at a lower cost and higher accuracy), we can expect good results with high accuracy.

Keywords: ArcGIS, geostatistical, snow water equivalent, snow density, snow depth