Presenting a soil moisture-based drought index derived from Global Land Data Assimilation System (GLDAS-SMDI) in Central Iran

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Extended abstract

Introduction

Droughts are long-term phenomena that affect vast areas, causing significant economic damages andlosses in human lives. Droughts are the most costly natural disaster in the world, and affect more people than any other natural disaster. Therefore, it is important to develop early warning systems to mitigate the effects of drought. The easiest way to monitor drought is to use drought indices that calculate drought severity, duration and actual range for each drought type. Several drought indices have been developed based on different variables and parametersto assess drought types. Soil moisture is a significant hydrological variable related to flood and drought and plays an important role in the process of converting precipitation into runoff andstorage of groundwater. Due to the difficulty, cost and time required for the field measurements of soil moisture, this parameter has not been widely used in drought indexes. Recent developments of global databases, based on satellite estimates, as well as rapid progress in hardware and software for modeling complex processes governing the water balance at the ground surface, have led to many efforts to deploy this new tool to reduce the limitations in this field. In this research, a new drought index based on soil moisture, derived from the land surface models of Global Land Data Assimilation System (GLDAS-SMDI) has been provided to monitor the evolution of drought severity.Thisindex is based on the fact that soil moisture is a determinant factor in most of complex environmental processes and has an important role in the occurrence of drought.

Materials and Methods

The central Iran is located between 27N-37N latitudes and 48E-61E longitudes with an area of about 837,184 km^2. There are 50 synoptic stations within the area. In the present study, soil moisture derived from Global Land Data Assimilation System using the GLDAS-SMDI index was used to prepare the spatial distribution map of drought in central Iran over the period of 2001-2004. The accuracy of the GLDAS-SMDI index based on satellite data was carried out using the evaluation criteria of R and RMSE compared with drought spatial distribution map derived from

the SPI index based on monthly precipitationdata of 50 synoptic stations.

Results and Discussion

In this study, the drought spatial distribution index of Soil Moisture based on the Global Land Data Assimilation System (GLDAS-SMDI) and SPI was obtained based on the monthly precipitation data from 50 synoptic stations over the period of 2001-2004. The results of the statistical criteria of the moisture drought spatial distribution mapcompatibility assessment based on GLDAS data with corresponding pixels on the drought spatial distribution map based on the precipitation data of thesynoptic stations showed that the drought severity map has had a high precision and good conformity with the land data (R=0.65, RMSE=0.22) based on GLDAS data.The highest correlation coefficient (0.74) was in 2004 and the lowest (0.45) in 2003.

The lowest and the highest mean errors in 2004 and 2001were 0.19 and 0.26, respectively,.The highest droughtseverity based on the GLDAS-SMDI index occurred in the Central Iran region at Iranshahr, Kahnuj, Bam, Baft and Birjand stationsduring the studied period.

Conclusion

Droughts are hydro-meteorological anomalies characterized by prolonged shortage in regional water supply and can cause temporary difficulties (even failures) in water reservoirs. Today, most of the severe droughts are breaking out in terms of frequency, magnitude and duration due to constantly increasing water consumption, causing serious social, economic and environmental problems worldwide. Therefore, in order to deal with frequent droughts, great efforts have been made to estimate a more accurate assessment for better decision-making in order to prevent and mitigate drought losses. The most successful efforts among these methods might be the development and the use of various objective indices. In this research, the monthlymoisture data of the Global Land Data Assimilation System was evaluated to estimate the drought severity index based on soil moisture. The evaluation was performed using the coefficient of determination (R^2) and Root Mean Square Error (RMSE). This analysis has demonstrated that the GLDAS products have very good compatibility with the land data over the selected area of Central Iran on monthly timescales and a 0.25° spatial scale. As a result, it can be said that the GLDAS data has a good potential for useful application of hydrological simulation and the calculation of water balance sheet, in the regions with low observations and low quality station. Therefore, it can be concluded that the soil moisture output of Global Land Data Assimilation System can be used for rapid and low cost estimation of drought severity based on soil moisture, which is a major factor in many complex environmental processes and has an important role in the occurrence ofdrought. In order to increase the spatial accuracy of drought intensity maps, it is recommended that the satellite data be combined with the values of ground stations.

Keywords: Dro u ght Monitoring, Soil Moisture, Global Land Data Assimilation System, GLDAS-SMDI index, Central Iran