A New Method for Drought Risk Assessment by Integrating the TRMM Monthly Rainfall Data and the Terra/MODIS NDVI Data in Fars Province, Iran

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Extended Abstract

Introduction
Drought monitoring and assessment is usually done through either ground observation or remote sensing. Due to having some limitations, gathering and analyzing ground observations are a time-consuming and expensive way to approach a precise drought monitoring and assessment. In contrast, remote sensing represents a fast and economic way of monitoring, but an applicable approach needs to be developed. To this end, using satellite sensor data which are continuously available provides cost-effective data for a better understanding of the region. They can be used to detect the drought commencement, duration and magnitude. Tropical Rainfall Measuring Mission monthly data (TRMM-3B43) and Monthly Normalized Difference Vegetation Index (NDVI) data of the MODIS on Terra satellite are freely available for this objective. The main objectives of the present study, which was carried out in the Fars Province, Iran, were: 1. integrating the satellite data for mapping drought severity classes using the Standardized Precipitation Index (SPI) and the NDVI anomaly maps, 2. creating drought risk maps, 3. calculating the percentage of drought affected area by drought risk level, 4. showing the effectiveness of satellite derived drought indices as an indicator for drought assessment, and 5. identifying the most drought vulnerable areas of the surveyed region.
Methodology
This research was carried out in Fars Province, Iran. It is located between 50°30’ and 55°36 E longitude and from 27°03’ to 31°42’ N latitude and cover an approximate area of 122661 km². This study aimed to map drought risk area in the Fars Province, by integrating the Standard Precipitation Index (SPI) and the Normalized Difference Vegetation Index (NDVI) Anomaly methods. As the first step, the growing season-based SPI (April-September) at 44 stations were calculated for 2000-2008 period using the standard normal distribution. The SPI raster layer (for each year), was created using the ordinary Kriging method. Then, all SPI maps were reclassified into five drought severity classes. As the second step, NDVI anomaly maps were created for the growing season based-NDVI anomaly of MODIS during the same period (9-year period). The NDVI anomaly map in each year was reclassified into five classes in a similar way. At the next part, for both methods, Boolean drought frequency map (presence or absence of drought) derived for each year. The derivation of final drought risk map was done by a simple weighted linear combination of the drought frequency maps. In this research, another drought risk map was created by integrating the NDVI anomaly and the TRMM-based SPI maps to introduce a new remote sensing method.

Results and Discussion
The ground-based SPI method applied for the growing seasons showed that in 2000, 2001, 2005 and 2008, some severe droughts occurred whereas the NDVI anomaly resulted in 2000, 2001 and 2008. The drought severity maps of TRMM based on SPI method indicated some noticeable drought occurrences in the Fars Province in 2000, 2005, and 2008 as well. The comparison of drought risk maps created by the TRMM-based SPI and the ground-based SPI methods showed that the majority of the surveyed regions are highly prone to drought occurrence. The TRMM could predict the monthly rainfall at most of 44 rain-gauge stations. Comparing drought risk maps, the high and moderate risk classes in the first method contain % 59.58 and % 39.84, while in the TRMM based method, they cover %61.1 and %37.12 of the area, respectively. Before drought risk assessment, it is highly recommended to evaluate the TRMM data for future events. The risk maps can be compared with the actual decrease in agricultural products for a better understanding of the events and their verifications.

Conclusion
The method applied in this study showed that almost whole the province is prone to drought occurrences. The northern and southern areas of the province were more susceptible to drought with different severities during the growing seasons in 2000-2008. It is notable to express that there are still some limitations to apply the satellite data for a long period. These might be data availability problem with moderate spatial resolution. The TRMM and the MODIS data have been available since 2000 and 1998, respectively. Furthermore, the TRMM data calibration and validation is required before creating the TRMM-based SPI maps. Despite their shortages, the application of remote sensing data for drought risk assessment can still be done as an acceptable method in ungauged regions.

Keywords: Drought, Fars, MODIS, NDVI Anomaly, TRMM.