Evaluation of Precipitation Products of TRMM Satellite in Precipitation and Erosion Rate Monitoring across Iran

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Extended abstract

1- Introduction

In order to calculate the erosive power of rainfall, high-resolution precipitation data are necessary for rainfall erosion evaluation. However, collecting the required data on kinetic energy of the rainfall particles and precipitation rates with short-term temporal resolution is a time-intensive task, particularly in developing countries, and the collected data are difficult to process. Rain sensors provide valuable information on the rate and intensity of rainfall, but fail to adequately represent irregular and inconsistent spatial distribution of the precipitation when evaluating the precipitation rate as those perform point measurements of precipitation. Under such circumstances, evaluation of precipitation rate from satellite data provides an alternative approach to the problem, which makes it possible to estimate precipitation rate and its spatial distribution across large areas. All around the world, several research works have been performed to estimate soil erodibility factor using the precipitation product of TRMM sensor, while no research has used such products for erosion and erodibility studies in Iran. Given that a limiting factor for estimating rainfall erosive power across large areas in Iran has been the lack of required data on precipitation intensity or precipitation rate, the present research can provide an approach to address such limitations. This study is aimed at monitoring the precipitation and hence evaluating and monitoring soil erodibility factor using precipitation products of TRMM sensor and comparing the results with those of terrestrial stations

2- Methodology

In this research, in order to use Modified Fournier Index (MFI) to estimate corrosive rate during 2000, 2005, 2010, and 2015, monthly precipitation products data of TRMM3B24 sensor was retrieved from http://apdrc.soest.hawaii.edu for all months of the considered years. Then, using the Fournier index and the equation proposed by Renard and Ferimvend, the erosive rate for the entire country was extracted for the four years considered in this study. In order to verify and evaluate the accuracy of the precipitation products of TRMM sensor, the monthly precipitation data collected from 45 terrestrial stations were used, and interpolation technique was used to develop precipitation and erosion maps based on the terrestrial data. Accuracy of the precipitation products of TRMM sensor was verified based on root-mean-square error (RMSE) and coefficient of determination (CD) of the annual precipitation at the pixel position of the synoptic stations.

3- Results

Results of evaluating annual precipitation rates indicated among the monitored years, the 2010 had experienced the lowest level of precipitation, while the 2000 was the year with the highest precipition level. A review on rainfall erosion maps indicated that, in 2000, the areas of the country with the highest erosion rates corresponded to the Middle Zagros and Caspian areas. The country's erosion map in 2005 closely resembled that in 2000, the erosion rates in the southern Kerman and northern Hormozgan were significantly lower than 2005. In 2010, when mean annual precipitation exhibited a low, the Chabahar Area exhibited the lowest erosion rate across the country, because of the intrusion of a seasonal air mass in June. In 2015, once again, maximum erosion rate across the country corresponded to those in 2000 and 2005, as determined by increased precipitation rate. A comparison between annual precipitation data collected from TRMM sensor and synoptic stations showed that, during all of the four

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years, an adequately good R2 value was established between the data from TRMM and that from terrestrial stations. The highest value of R2 between the TRMM and terrestrial stations data was obtained for 2000 (0.86), while the lowest R2 value was that of 2015 (0.73). The obtained value of RMSE showed that, in 2000 (the year with the highest precipitation rate among the monitored years), the value of RMSE was 152 mm. For this year, the difference between the peak participation estimated from the two methodologies was 406 mm, which was mainly related to the four stations with the highest precipitation rates. In 2005, the difference between the peak participation estimated based on the data from the two sources was 543 mm, with a RMSE of 205 mm. Also in this year, the difference between minimum precipitation values was highest, as compared to the other years considered in this study. In 2010, the difference between the peak participation estimated based on the data from the two sources was 533 mm, with the RMSE reduced to 129 mm.

4- Discussion & Conclusions

Spatial resolution includes terrestrial dimensions of each pixel of the image and determines accuracy of the image. Terrestrial dimensions of each pixel of the precipitation products of TRMM is 25 km by 25 km. Given the nature and definition of the pixel, it is the smallest spatial unit with its most important characteristic being the consistency across the entire pixel. Accordingly, the 625-km2 area of each pixel of an image from TRMM takes only one numerical value (DN) which is an average value of the precipitation across the entire 625-km2 area. Therefore, accuracy of each pixel in recording the precipitation depends on the variations of precipitation across the mentioned area. Terrestrial stations provide point estimations of precipitation, and interpolation technique is used to prepare erosion and precipitation maps from terrestrial stations. Accordingly, the higher the number of points included in the process of interpolation, the more flexible will be the resultant interpolated map. Given the fundamental differences between precipitation measurements by satellite sensors and classic terrestrial stations, it is difficult to firmly express that the data from terrestrial stations shall be taken as reference data and the remote sensing data shall be verified against the terrestrial data, because even in point measurements, there are cases where the precipitation condition in points near the measurement point is significantly different from that at the measurement point.

Key Words: Spatial Data, Erosion, Environmental Hazards, Land Management.