Validation of TRMM 3B42 V6 for estimation of mean annual rainfall over ungauged area in semiarid climate

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Received: 20 December 2016 / Accepted: 27 July 2017
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Abstract This research compares data from the Tropical Rainfall Measuring Mission 3B42 V6 with data obtained from 19 synoptic rain gauges during the period 1998–2010 over the semiarid climate of Khorasan Razavi, Iran. Validation was performed using three spatial extents, including 1 TRMM grid face from the synoptic station (1PTRM), 3 TRMM points surrounding the synoptic station (3PTRM) and 5 TRMM points surrounding the synoptic station (5PTRM), using ArcGIS 10.2 software. The perfect and poor r values were obtained at stations S08 and S19, with values of 0.92 and 0.26, respectively. According to the Nash–Sutcliffe efficiency coefficient, the TRMM satellite can predict the spatial variation of the mean annual rainfall by 0.23, 0.43 and 0.38 for 1PTRM, 3PTRM and 5PTRM, respectively, at 19 stations. The agreement significantly increases by 0.88, 0.83 and 0.80 for 1PTRM, 3PTRM and 5PTRM, respectively, when gauges S05, S07, S11 and S13 are excluded from the dataset, which may be associated with orographic or instrumental error at the stations.

Keywords TRMM V6 · Mean annual rainfall · Semiarid · Khorasan

Introduction

Estimating rainfall in arid and semiarid regions with a sparse rain gauge network is challenging for decision-makers and water resource managers. Accurate precipitation measurement is essential for determining the spatial and temporal variations of rainfall, which are necessary for hydrological modelling. Estimating rainfall over Khorasan Razavi, which has a rugged topography, is difficult due to the sparse distribution of rain gauges in the area. Rainfall data are typically obtained from rain gauges, which represent point measurements. Thus, rain gauges provide direct, in situ measurements. However, the number of stations with rain gauges is inadequate in many regions, particularly in Khorasan Razavi. A sparse rain gauge network across undulating topography results in a high level of uncertainty when estimating mean annual rainfall (MAR) using point interpolation methods, such as inverse distance, Thiessen polygon and kriging methods. The Tropical Rainfall Measuring Mission 3B42 version 6 (hereafter referred to as TRMM) is freely available since 1998 with relatively high spatial (0.25° × 0.25°), temporal resolutions (3 h) and a geographical coverage of 50°S–50°N. These satellite-based rainfall data are very useful in semiarid regions, where rain gauges are sparse or absent. The main problem with satellite-based rainfall measurements is bias (Katirae-Boroujerdy et al. 2013), which can result from the precipitation algorithm or unusual surface or atmospheric conditions that were incorrectly interpreted by a predefined algorithm. Therefore, the quality of satellite data must be evaluated over different climatic and geographical regions (Katirae-Boroujerdy et al. 2013) to determine its reliability and to better understand the spatial and temporal variations of rainfall. Previous studies of TRMM validation can be classified at global, continental,