EVALUATION AND BIAS CORRECTION OF REMOTELY SENSED PRECIPITATION FOR PAKISTAN

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ABSTRACT

The precise assessment of precipitation is extremely important for survival and sustainable development of humans. Conventionally rain gauges have been used for quantification of rainfall. Later on precipitation radar supplemented rain gauge data. Inventions in remote sensing and development of satellite based precipitation estimation products further facilitated in quantification of precipitation. In Pakistan the conventional rain gauge system is scares in spatial resolution. The PMD has established meteorological radars at various weather stations to supplement the rain gauge system but limited in number. Under such circumstances utilization of satellite based precipitation is receiving more attention in recent decade.

As the satellite based precipitation estimation is an indirect approach based on recording the reflection in various wavelength bands of light from the upper surface of clouds. Therefore the satellite based precipitation estimates may have uncertainties due to upper atmospheric conditions, topography of the area, prevailing climatic conditions, seasonal variability and intensity of precipitation. Hence the uncertainties normally termed as biases, needed to be corrected before application of satellite based precipitation data in hydrologic applications.

Many studies have been conducted on assessment and bias correction of satellite precipitation data around the globe but all such studies are specific for certain areas. In the present study assessment of well known high resolution multi-satellite precipitation estimation products IMERG, TMPA, PERSIANN and CMORPH was conducted under varied climatic and topographic conditions in Pakistan. Identification and quantification of uncertainties associated with various satellite precipitation products was carried out and a new approach based on merging mechanism with reduced bias was introduced in this study.

Assessment of selected multi-satellite precipitation products was carried out on entire study area and regional basis (dividing the study area into five regions having diverse topography and climate). Evaluating statistical indices including Correlation Coefficient (CC), Bias (Bias), Root Mean Square Error (RMSE) were applied. In addition to above detective statistical indices e.g. Probability of Detection (POD), False Alarm Ratio (FAR), and Critical Success Index (CSI) were also used for identification of errors.

Error characterization (quantification of uncertainties) of multi-satellite high resolution satellite products was conducted by disintegration of Bias in to Hit-bias, Missed-bias, and False-bias and Root Mean Square Error in to Systematic and Random errors at grid (point) and regional scale. The developed new Integrated Framework based Precipitation (IFP) estimate was aimed at consistent performance throughout the study area with reduced bias. The IFP was based on the merging algorithm, which includes the satellite product estimates, demonstrating highest values of correlation coefficient (CC) among the applied satellite products and the resultant performance connection weights.

Satellite products, Global Precipitation Measurement (GPM) IMERG research (IMRS), IMERG real time (IMRT), TMPA 3B42 real time (TMPA), PERSIANN (PERS) and CMORPH (CMOR) was evaluated against rain-gauge data to assess their performance in the study area. An inter comparison among above mentioned satellite products was also carried out on regional and entire study area basis, in order to find the most suitable precipitation product for the study area.

The assessment results of the selected satellite products against rain gauge data, on daily basis showed a week correlation (CC<0.30), comparatively low average value of POD (<32%), CSI (< 20 %) at regional as well as grid scale. Performance of satellite

based products improved in plain areas and areas with sufficient (moderate) rainfall. In high altitude areas results were not satisfactory due to complex topography and climatic conditions. Inter comparison of satellite products revealed better performance of IMRERG products than TMPA 3B42, CMORPH and PERSIAN. At monthly timescale, the CC values in the range of 0.6 to 1.0 were observed.

In quantification of uncertainties, results of total Bias (0-0.2) were encouraging. Although some under/over estimations were noted in Hit bias (-0.15 to 0.15) at average daily scale in mm. Relatively higher values of averaged daily Missed (0.2 to 0.5) and Flase (0.45 to 0.7) biases were observed. The average daily RMSE (6 to7.5), Systematic error (3 to 4) and Random error (4.5 to 6) errors were also relatively higher. Assessment of developed IFP against PMD rain gauge data was also conducted. The comprehensive analyses among the used satellite products and IFP (average CC: 0.35; POD: 40% and CSI: 25%) revealed improved efficiency and better agreement of IFP with the gauged data sets, as compared to the other satellite precipitation products over the entire study area.

Being the first comprehensive study in this field in Pakistan, it was found that satellite based precipitation products have potential to supplement conventional rain gauge measurement system in Pakistan. Missed precipitation and false alarm were the major associated uncertainties in the study area. The developed IFP model, using IMERG and TMPA data provided better application over the entire study area. Assessment of satellite based estimates may be conducted in this area based on seasonal classifications and varied precipitation intensities. The developed IFP may be verified for seasonal classifications and hydrologic modeling.