Climatological study of Satellite Sensed Precipitation along the mountainous regions of Nepal

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Introduction:

- The study focuses on the characteristics of the CHIRPS version 2.0 dataset and extreme events in Gandaki Province, Nepal. Firstly, we validate the CHIRPS dataset against in-situ data from the Department of Hydrology and Meteorology (DHM), Nepal, covering the period from 1992 to 2022. Subsequently, we investigate extreme events and calculate the Probable Maximum Precipitation (PMP) using the Hershfield technique (Hershfield, 1961).
- We analyzed 28-point base data from DHM to identify the accuracy of the CHIRPS data. Additionally, 5 km grid-point CHIRPS data were used to calculate extreme events.

Conclusion:

- The findings revealed that the correlation coefficient is greater than 80% for elevations less than 2566 meters and between 51-61% for elevations ranging from 2566 to 2744 meters. For the overall study area, the daily climatology correlation coefficient between CHIRPS and DHM data is 80%, and the RMSE is 4.56.
- Lumle-Kaski, Lamjung, Syangja, and Nawalparasi had the most rainfall, with 3600 mm reported from 1992 to 2022 (CHIRPS), due to the orographic effect, geographic position, and local microclimate. Mustang, Manang, and the northern region of Gorkha had the lowest rainfall due to their location on the leeward side of the mountains.
- PMP analysis revealed that the calculated maximum probable precipitation (PMP) reached 540 mm/day, whereas the observed peak rainfall recorded was 400 mm/day.

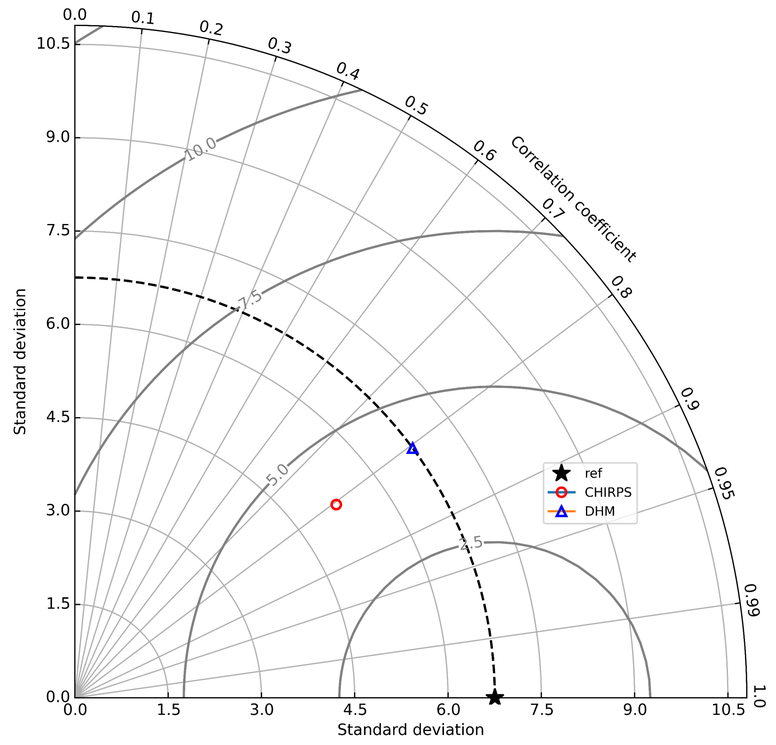

Figure 1: Taylor diagram indicating daily climatology's standard deviation, correlation coefficient, and centered root mean square error from 1992-2022.

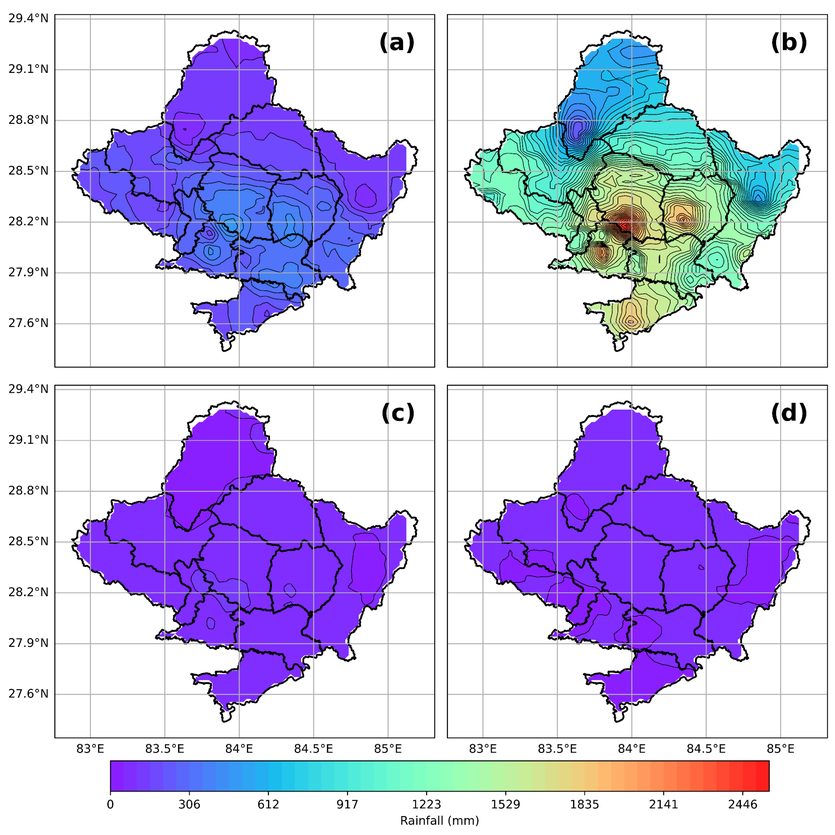

Figure 2: Seasonal accumulated precipitation, (a) Pre-monsoon, (b) Monsoon, (c) Post-monsoon, and (d) Winter. The climatology was examined using the 5-kilometer CHIRPS precipitation dataset from 1992 to 2022.

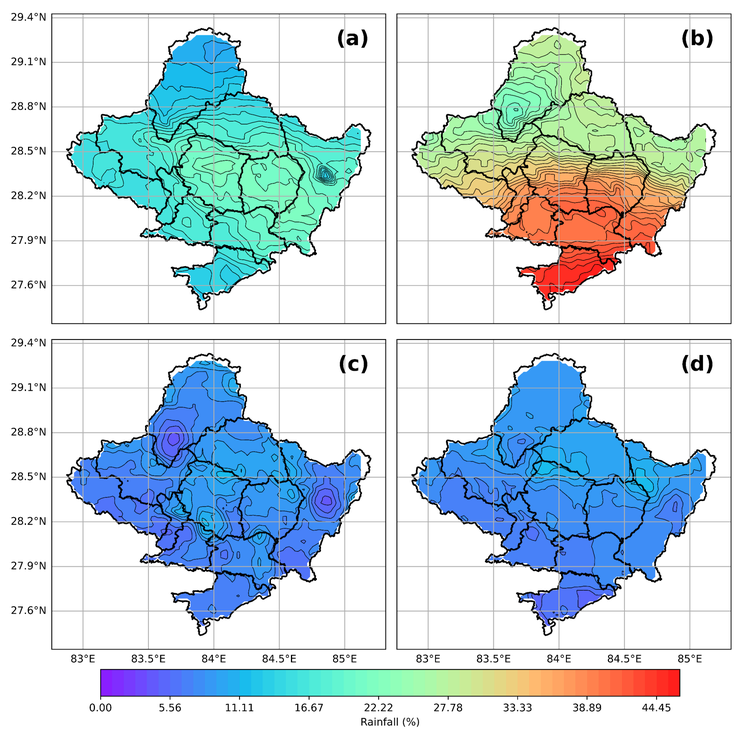

Figure 3: Seasonal rainfall frequency of days greater than or equal to 1mm per day, (a) Pre-monsoon, (b) Monsoon, (c) Post-monsoon, and (d) winter. The climatology was examined using the 5-kilometer CHIRPS precipitation dataset from 1992 to 2022.

Rainfall frequency = Total no. of days with ≥ 1mm rainfall/Total days of the entire year *(Sun et al, 2006 Josetine and Silvina A. 2017).*

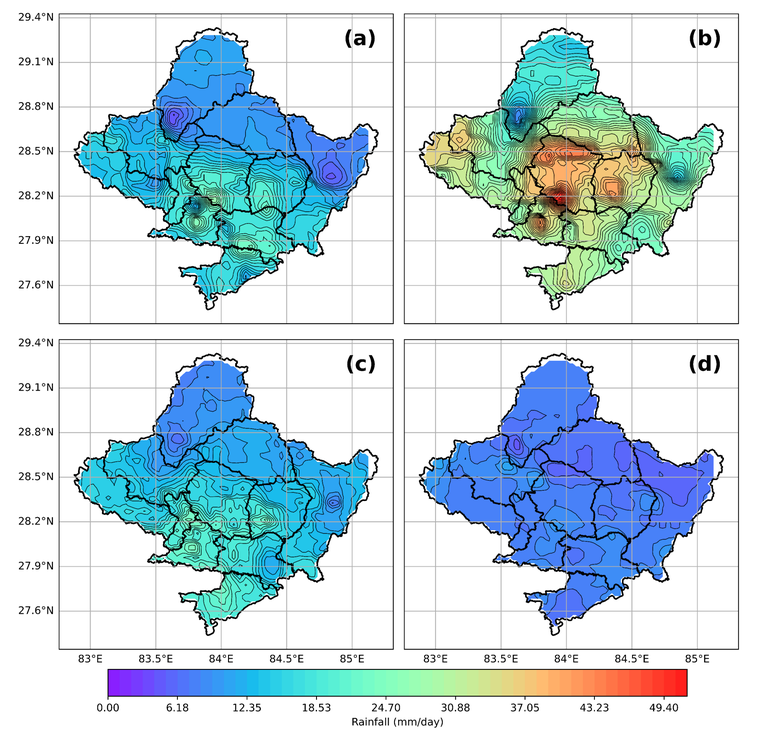

Figure 4: Seasonal rainfall intensity, (a) Pre-monsoon, (b) Monsoon, (c) Post-monsoon, and (d) winter. The climatology was examined using the 5-kilometer CHIRPS precipitation dataset from 1992 to 2022.

Rainfall intensity = Total rainfall ≥ 1mm/Total no. of days having ≥ 1mm rainfall.

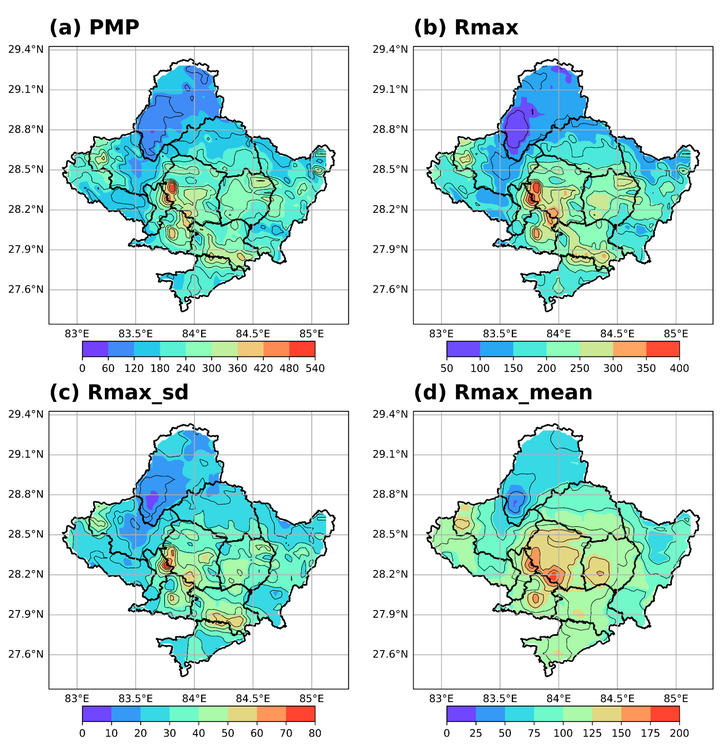

Figure 6: (a) Probable Maximum Precipitation computed using Hershfield technique (Hershfield, 1961) (PMP; mm/day), (b) 31-year maximum precipitation (Rmax; mm/day), (c) maximum precipitation standard deviation (Rmax_sd; mm/day), and (d) maximum precipitation mean (Rmax_mean; mm/day). The climatology was examined using the 5-kilometer CHIRPS precipitation dataset from 1992 to 2022.

Probable Maximum Precipitation is the maximum depth of precipitation at a location that is meteorologically possible for a particular duration of time. *(Kunkel et al., 2013) (Fernando and Wickramasuriya, 2011) (Casas et al., 2011) (Papalexiou and Koutsoyiannis, 2006) (ALIAS, LUO and TAKARA, 2013) (WMO, 1987) (Gupta, Konduru and Singh, 2023)*

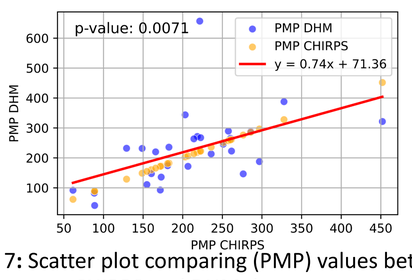

Figure 7: Scatter plot comparing (PMP) values between CHIRPS and DHM datasets.

$$PMP = \overline{x_n} + f_m \sigma_n$$

Where,

$$\overline{x_n} = \sum_{i=1}^{n} \frac{(X_{max})_i}{n}$$

$$\sigma_n = \sqrt{\sum_{i=1}^{n} \frac{\left((X_{max})_i - \overline{x_n}\right)^2}{n-1}}$$

and the frequency factor fm is defined as

$$f_m = \frac{(X_{max})_m - \overline{x_{n-1}}}{\sigma_{n-1}}; i \neq m \text{ and } n \neq m$$

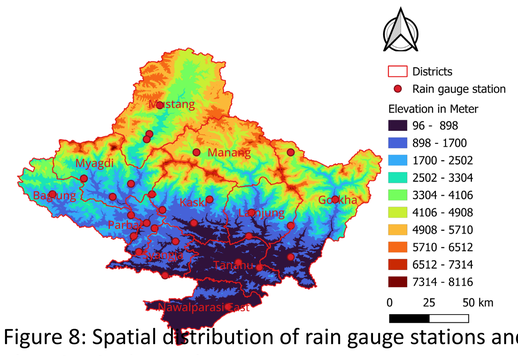

Figure 8: Spatial distribution of rain gauge stations and elevation in the study area.

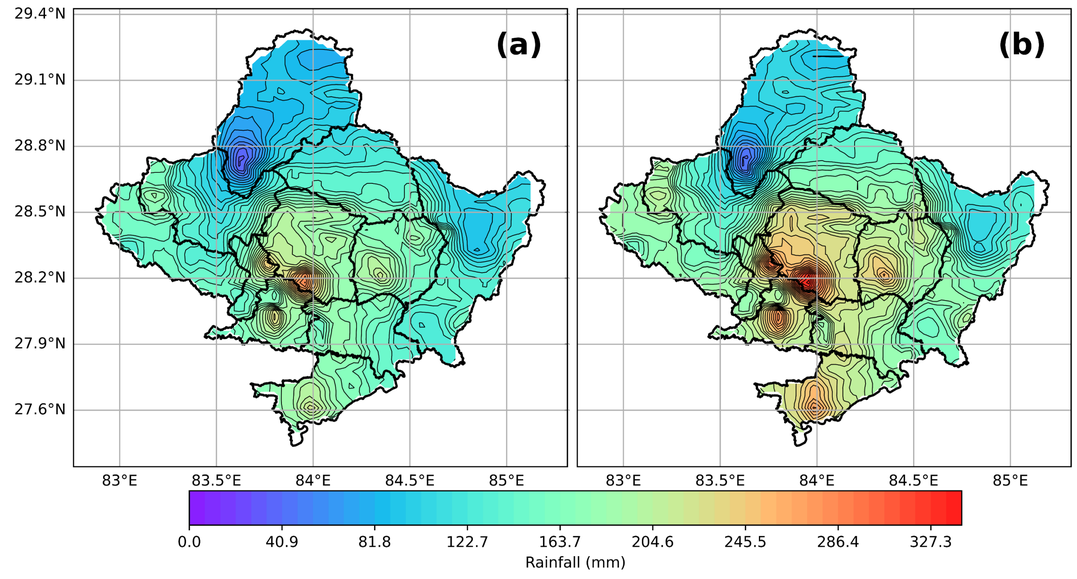

Figure 5: (a) 3-day maximum precipitation and (b) 5-day maximum precipitation. The climatology was examined using the 5-kilometer CHIRPS precipitation dataset from 1992 to 2022.

References:

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Thank you for the interesting questions…