ECWS-8 2024 Conference

The 8th International Electronic Conference on Water Sciences

14–16 October 2024 | Online

MDPI

PERFORMANCE EVALUATION OF ERA5, MERRA 2 AND PERSIANN-CDR REANALYSIS GRIDS IN THE TAMBO BASIN

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INTRODUCTION & AIM

Precipitation is a key climatic variable that influences various human activities and the hydrological cycle. Its spatial and temporal variability is essential for the planning and management of water resources, as well as for mitigating the effects of extreme events. However, obtaining accurate data faces limitations, especially in areas with sparse meteorological station infrastructure. In light of these challenges, satellite and reanalysis data present valuable alternatives to supplement the lack of information, although their accuracy may vary depending on factors such as topography and atmospheric conditions. Although reanalysis products offer broad coverage and high temporal frequency, they need to be validated to ensure their reliability and applicability in different climatic contexts.

The objective of this research is to evaluate the performance of three global climate reanalysis products ERA5, MERRA-2, and PERSIANN-CDR both at point level through meteorological stations and by mean areal precipitation in the Tambo basin, located in southern Peru.

METHOD

The Tambo Basin (TB) is located in the southern region of Peru, specifically in the department of Moquegua (Figure 1). With a drainage area covering approximately 11,826.63 km² up to the La Pascana hydrological station, near its mouth at the Pacific Ocean, this basin is vital for the region. The main river extends 146.67 km and traverses diverse terrain, with altitudes ranging from 5608 meters above sea level at its highest point, according to the Digital Elevation Model (DEM), to 213 meters above sea level at its lowest point, with an average altitude of 3741.52 meters above sea level and an average slope of 15.92%.

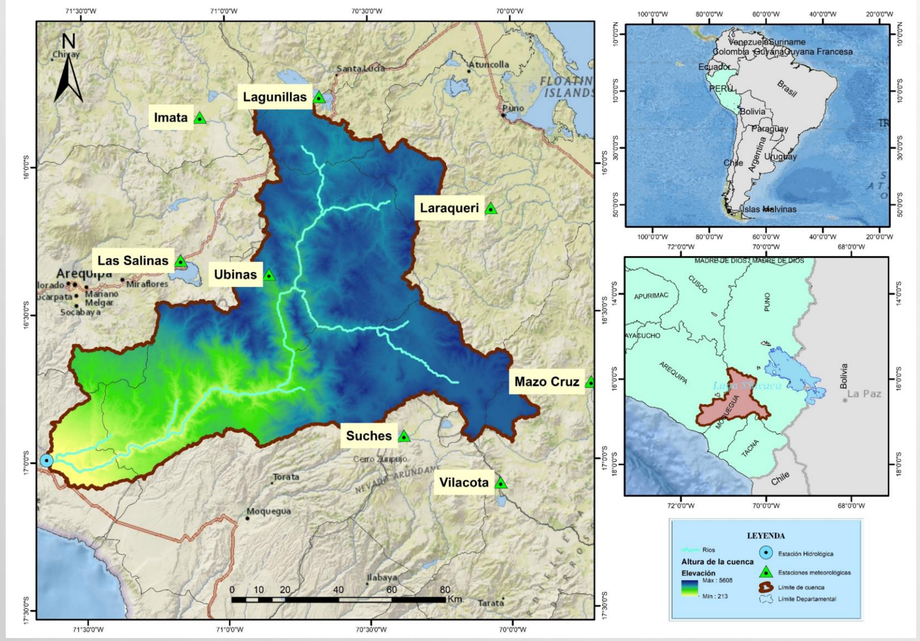

Figure 1. Location of the Tambo Basin with meteorological stations.

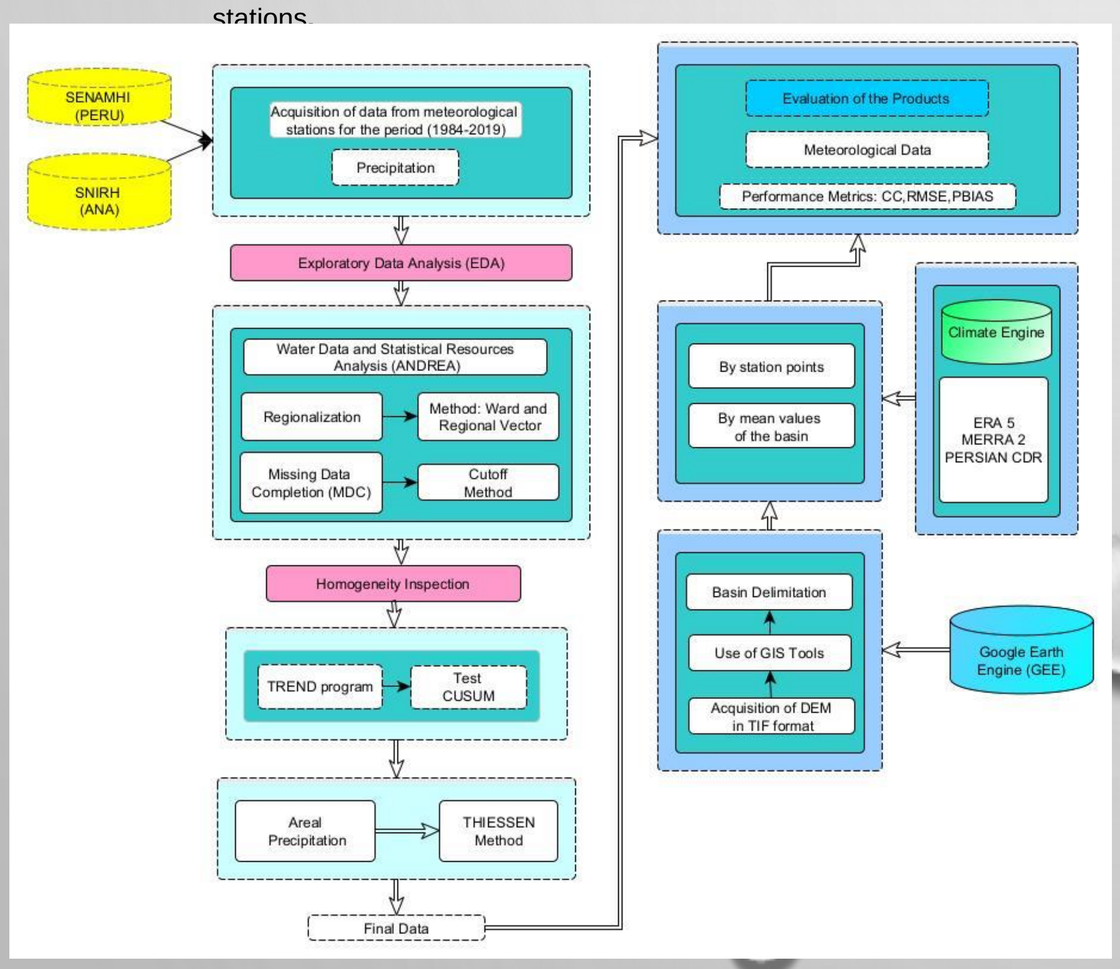

Figure 2. Methodology

RESULTS & DISCUSSION

1. Evaluation by meteorological station..

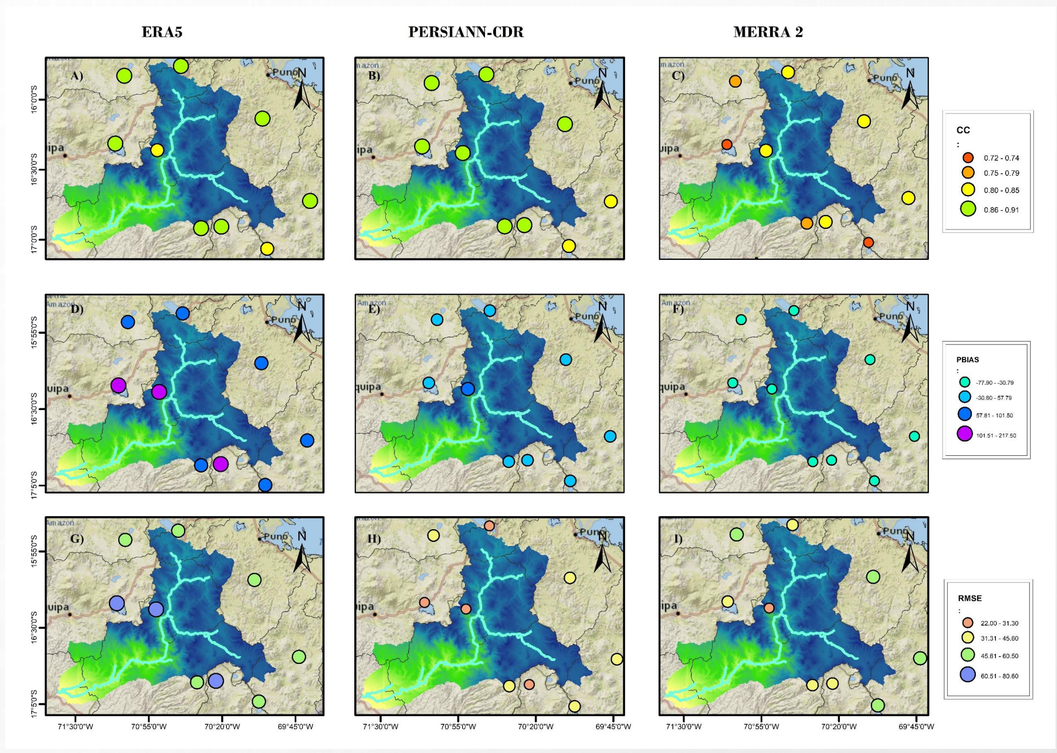

Figure 3. Spatial distribution of PBIAS-RMSE-CC of monthly rain gauge data in relation to ERA5, MERRA2, and PERSIANN-CDR**.**

2. Areal average evaluation.

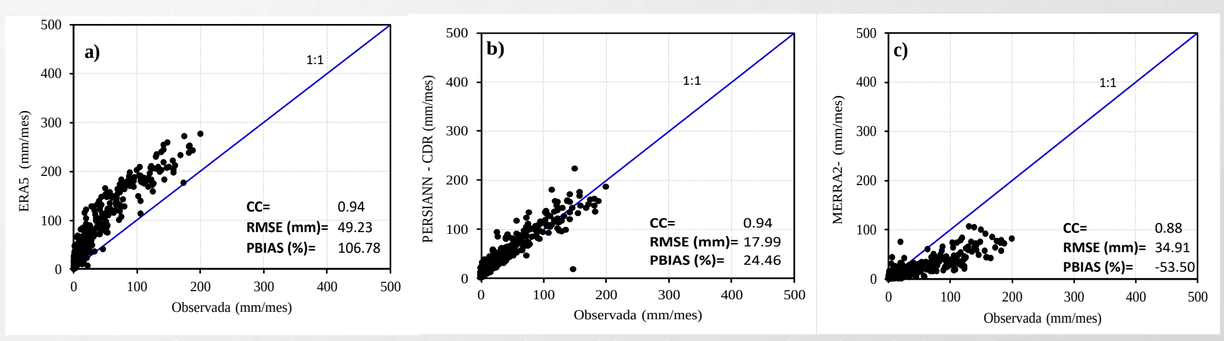

Figure 4. PBIAS-RMSE-CC of monthly rain gauge data in relation to ERA5, MERRA2, and PERSIANN-CDR.

The validation of precipitation products is essential for climate and hydrological studies (Wong et al., 2017). This study evaluated the accuracy of the reanalysis products ERA5, MERRA2, and PERSIANN-CDR in the Tambo basin, finding that PERSIANN-CDR is the most accurate, with lower percentage biases (PBIAS) and root mean square errors (RMSE), as well as a high correlation coefficient (CC), corroborating similar findings in the Titicaca basin (Lujano et al., 2023) and in South Asia (Hamza et al., 2020).ERA5 showed good temporal correlation, surpassing MERRA2 (Huang et al., 2021), but it exhibits a higher bias, attributable to the irregular distribution of stations (Clarke et al., 2011). MERRA2, while showing a good correlation, tends to underestimate precipitation (Gaibor Velasco et al., 2023; Quagraine et al., 2020).

CONCLUSION

In this study, the reanalysis products ERA5, MERRA2, and PERSIANN-CDR were evaluated for estimating precipitation in the Tambo basin. The results indicate that PERSIANN-CDR is the most accurate in terms of the magnitude of the estimated precipitation, excelling in its ability to provide values close to observed data. ERA5, while showing a high temporal correlation with observations, tends to overestimate precipitation, which could impact accuracy in hydrological modeling. MERRA2, on the other hand, offers an acceptable estimation in some aspects but has lower comparative accuracy compared to PERSIANN-CDR. These findings highlight the need to recognize the limitations of each reanalysis product and adjust the data accordingly. To improve accuracy in precipitation estimation, it is recommended to correct biases in the products and consider combining data from different sources. Additionally, further research in other basins is essential to assess the applicability of these products in various climatic and geographical contexts.

FUTURE WORK / REFERENCES

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Clarke, R. T., Buarque, D. C., de Paiva, R. C. D., & Collischonn, W. (2011). Issues of spatial correlation arising from the use of TRMM rainfall estimates in the Brazilian Amazon. *Water Resources Research*, *47*(5). https://doi.org/10.1029/2010WR010334