TC-318S

Evaluation of gridded rainfall products in the selected basins of Lower Mekong

Santosh Dhungana, Sangam Shrestha, Tuan Pham Van, Saurav KC, Ashim Das Gupta
Water Engineering and Management (WEM), Department of Civil and Infrastructure Engineering (CIE),
School of Environment and Technology (SET), Asian Institute of Technology (AIT),
P.O. Box 4, Klong Luang, Pathum Thani, 12120, Thailand
santosh.dhung@gmail.com

Key words: Gridded Rainfall Products, Entropy Method, Compromise Programming

ABSTRACT

Rainfall is a primary variable in many hydrological and meteorological studies and majority of these studies rely on direct gauge measurements. However, the reliable long-term gauge data are scarce especially in the developing nations like Laos and Vietnam. To fulfill the gap, gridded rainfall products (GRPs) are being developed and used at local to global scale application. However, these products have inherent uncertainties owing to their gridding algorithms, available gauge density and period of data available suggesting their evaluation prior to their applications. A wide assortment of GRPs evalution techniques ranging from a use of single criteria like correlation coefficient to multi-criteria technique like Cooperative Game Theory, Compromise programming, etc. are available.. Hence this study considers two important sub-basins with unkwown status of GRP evaluation in lower Mekong reion, Nam Ngum River Basin (NRB) in Laos that houses several dams and growing hydropower projects and Vietnam Mekong Delta (VMD) n Vietnam largely dependent on agriculture and aquaculture. Two monthly and six daily GRPs are considered for this study: Asian Rainfall Highly Resolved Observational Data Integration Towards Evaluation (APHRODITE), Climate Hazard Group InfraRed Rainfall with Station (CHIRPS), Climate Prediction Center (CPC) rainfall product, CPC MORPHing (CMORPH) dataset, Southeast Asian OBServed (SAOBS) dataset and Tropical Rainfall Measuring Mission (TRMM). Similarly, two monthly scale datasets are: Climate Research Unit (CRU) dataset and Global Rainfall Climatology Center (GPCC) dataset. Pixel-to-point comparison is carried out for the reference time period of 1998 to 2014 prior to weighing and ranking.

Almost all of the adopted techniques in former studies in Mekong River Basin (MRB) are largely influenced by the skill evaluater in prioritizing the evaluation criteria used and the prior knowledge of the climate of the study area. Hence, the main objective of this study is to utilize the entropy method to automatically assign weights to the criteria without influence of evaluator and rank the dataset using compromise programming. Equations 1 and 2 describes the entropy method for weight calculation and equation 3 represent compromise programming.

$$\mathrm{E}_j = -\frac{1}{\ln(n)}\sum_{a=1}^{n} R_{aj}\ln\left(R_{aj}\right) \text{ for } j = 1,2,\ldots\ldots J \qquad 1$$

$$w_j = \frac{1-E_j}{\sum_{j=1}^{J}(1-E_j)} \qquad 2$$

$$CP_p(a) = \left[\sum_{j=1}^{n} w_j\left|R_j^* - R_j(a)\right|^d\right]^{\frac{1}{d}} \qquad 3$$

Where E_j is the entropy, n is the number of GRPs and R_{aj} and R_j^* are the normalized value of jth evaluation criterion for GRP and observed data respectively, and w_j is the weight for the jth criterion. $CP_p(a)$ is the distance of the ath GRP, j is the evaluation criteria, D is the distance parameter(d=1 represents linear approach and d=2 indicate Euclidean distance).Higher E_j represents higher uncertainty and vice versa. Similarly, lower CP_p value indicate higher rank of dataset and vice versa.

The Taylor diagrams in figure 1 represents the ability of the GRPs to represent the mean monthly rainfall for NRB and Mekong Delta through the three statistical criteria: correlation coefficient, standard deviation, and root mean squared deviation. Performance of GRPs is variable across stations and individual criterion suggest different GRP. The entropy method employed finds the tradeoffs among criteria through weight distribution. The weights distribution for different criteria across different stations is presented in figure 2. For both NRB and VMD, bias dominates and largely influences the ranking of the GRPs. For a daily scale dataset, APHRODITE for NRB and TRMM for VMD outweighed other dataset in capturing mean monthly rainfall.

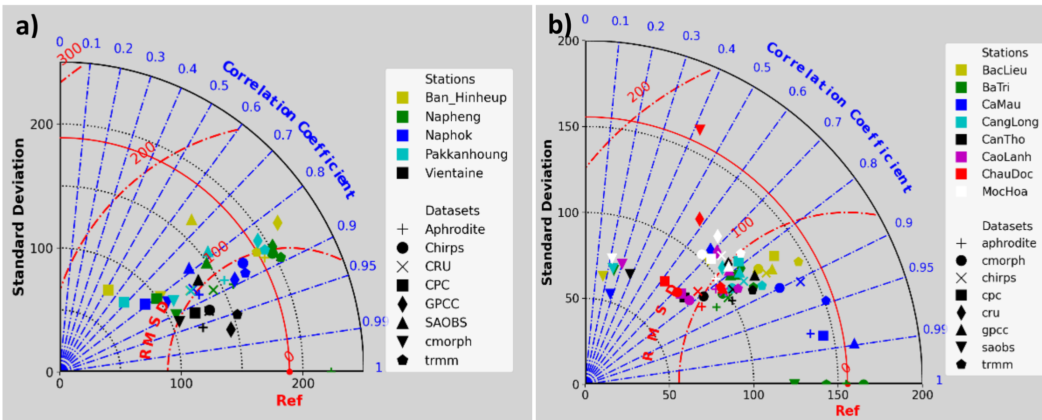

Figure 1:Taylor Diagram representing performance of GRPs across NRB; b) across VMD

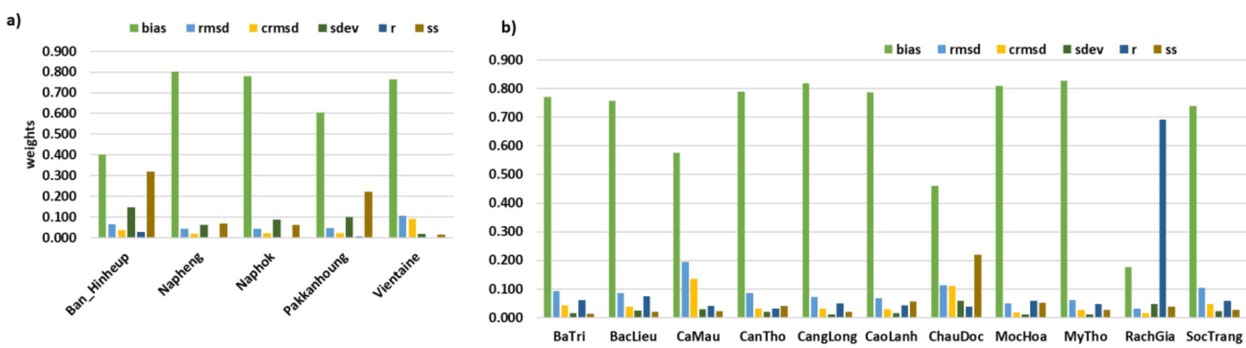

Figure 2: weight distribution among evaluation a) across NRB and b) across VMD

ACKNOWLEDGEMENTS

The authors would like to thank to the "Strengthening Groundwater Governance in Rapidly Urbanising Areas of the Lower Mekong Region (GIRA)" project funded by Stockholm Environment Institute (SEI) under the SUMERNET 4 All Programme which is funded by the Swedish International Development Cooperation Agency (Sida).

References

1. Dandridge, C., Lakshmi, V., Bolten, J., & Srinivasan, R. (2019). Evaluation of Satellite-Based Rainfall Estimates in the Lower Mekong River Basin (Southeast Asia). In Remote Sensing (Vol. 11, Issue 22).
2. Raju, K. S., & Kumar, D. N. (2014). Ranking of global climate models for India using multicriterion analysis. Climate Research, 60, 103–117.