Multi-dataset optimization of a rain gauge network for a poorly observed watershed

Natalia Horna[1], Christopher Fletcher[1]

1 Department of Geography & Environmental Management, University of Waterloo, Canada

Email: nhornaku@uwaterloo.ca

Abstract

A well distributed observation network has the ability to substantially improve the understanding of rainfall for water resources applications, particularly in water abundant areas like the Napo River watershed in Ecuador. This watershed drains the eastern slopes of the Ecuadorian Andes; and is one of the main tributaries of the Amazon River. Despite its high hydroelectric potential and the expected increase of extreme precipitation events related to climate change, this region remains poorly gauged due to accessibility issues. To optimize rain gauge networks with sufficient and representative information, conventional approaches rely on existing information from stations, but given the low amount of long-term data in this area this research proposes the use of an entropy-based method based on information theory for the augmentation of the rain gauge network using multiple datasets. Precipitation information from the existing rain gauge network is combined with the Multi-Source Weighted-Ensemble Precipitation (MSWEP) and ECWMWF reanalysis v5 (ERA5) gridded products in the Napo River watershed in Ecuador. The quantitative evaluation reveals that the products capture well gauge-measured precipitation in the drier lowlands, but still underestimate precipitation in the wetter parts of the watershed. The combined networks (stations and pixels) are ranked based on the contribution to the joint entropy using a greedy ranking algorithm. The similarity between the two designs is that joint entropy reaches a stable value at point 13. Also, the first five most informative points are the same: four existing stations and a fifth location in the southeast side of the watershed; however, the remaining eight proposed points for each design are highly different because each product detects different areas of high precipitation intensity and variability, and the most informative locations are ranked in those areas. The results indicate that the product type and spatial resolution affect the final design of the network, but this method shows promise for the use of gridded products in poorly gauged areas.

Keywords: Information theory, Shannon entropy, MSWEP, ERA5, remote sensing, Ecuador