Fusion of Sentinel-1 radar and Sentinel-2 MSI imagery for water extraction in Tibetan plateau

Dan Li¹, Baosheng Wu¹, Bowei Chen², Yanjun Wang³, Yi Zhang¹, Yuan Xue¹, and Chao Qin¹
¹State Key Laboratory of Hydrosience and Engineering, Tsinghua University, Beijing 100084, PR China (glninchao@nwsuaf.edu.cn)
²Key Laboratory of Digital Earth Science, Institute of Remote Sensing and Digital Earth, Chinese Academy of Sciences, Beijing 100094, China (chenbw@aircas.ac.cn)
³Changjiang River Scientific Research Institute; and Key Laboratory of River Regulation and Flood Control of the Ministry of Water Resources, Wuhan 430010, China (yanjun1113@126.com)

Abstract: Water plays a vital role in plants, animals and human survival, as well as water resources planning and protection. The spatial and temporal changes of rivers have a profound impact on climate change and the scientific protection of the regional ecological environment in Qingzang-Tibet plateau. Due to the influence of snow and cloud cover, optical remote sensing images in this region have less effective coverage. Many researches in the past mainly faced the challenge of misclassification caused by shadows from cloud and mountain. In this study, we proposed a method to improve the extraction of rivers by reducing the effect of shadows by fusing Sentinel-1 radar data and Sentinel-2 optical imagery. For the optical imagery, water indices including MNDWI (Modified Normalized Difference Water Index) and RNDWI (Revised Normalized Difference Water Index) and morphological operations were used to extract the river coverage. In addition, radar data is used to extract water in areas where there is no optical image coverage or where optical images are misclassified by using a combination of both the histogram and Otsu threshold methods. The GEE (Google Earth Engine) platform is used to implement the analysis using two classification datasets at a regional level. Relevant results from Sentinel-1 and Sentinel-2 data showed that the RNDWI has a more accurate water extraction results in this region. We further compared the final river width results with the manually measured samples from Google Earth and situ data of hydrological stations for accuracy assessment. The $R^2$ value is 0.90, and the standard deviation is 18.663m. The river width can be estimated well by this method, which can provide basic data for the study of water in depopulated zone.

Keywords: Remote sensing, shadow removal, water extraction, water index, Otsu threshold, Google Earth Engine