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Remotely sensed estimate of river discharge using the area-discharge relationship and Sentinel-1 SAR imagery

Minji Seo (1), Dongkyun Kim (2), and Waqas Ahmad (1)

(1) Hongik University, Department of Civil Engineering, Seoul, Republic of Korea, (2) Hongik University, Department of Civil Engineering, Seoul, Republic Of Korea (kim.dongkyun@hongik.ac.kr)

Estimation of river discharge is an important component in planning, development, operation and management of water resources projects. Limited resources and inaccessibility to the required measurement sites in remote areas are the likely constraint in flow estimation in a number of watersheds worldwide. The increasing availability of microwave remote sensing products such as Sentinel-1 has a great potential to estimate stream discharge at a regular interval due to its fixed revisit time, capability to operate in day-night and all weather conditions. This research proposes a methodology to make use of the Sentinel-1 Synthetic Aperture Radar (SAR) imagery to estimate discharge at eleven stations in the Han River basin, South Korea. A time series of twelve Sentinel-1 SAR images for each station was used to develop and validate a relationship between the observed discharge and the surface area of the river. First, the twelve images collected for each station are normalized using the histogram matching technique. Second, the vicinity of the river is chosen for the further analysis (the remaining area is masked out). Third, the two-dimensional optimization technique is applied to find out the power value to be applied to the image pixel values and the threshold value to separate between the waterbody that maximizes the R2 value of the regression between the waterbody and flow discharge value. The R2 value of the regression between the two variable varied between 0.50 and 0.98. The established regression relationship at each station was validated using the additional six images obtained in 2017. The match between the water body and flow discharge value was better for the river with greater discharge and for the flatter river area.