Stream flow estimation in small to large size streams using Sentinel-1 Synthetic Aperture Radar (SAR) data in Han River Basin, Korea

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Abstract

This study demonstrates a novel approach of remotely sensed estimates of stream flow at fifteen hydrological station in the Han River Basin, Korea. Multi-temporal data of the European Space Agency's Sentinel-1 SAR satellite from 19 January, 2015 to 25 August, 2018 is used to develop and validate the flow estimation model for each station. The flow estimation model is based on a power law relationship established between the remotely sensed surface area of water at a selected reach of the stream and the observed discharge. The satellite images were pre-processed for thermal noise, radiometric, speckle and terrain correction. The difference in SAR image brightness caused by the differences in SAR satellite look angle and atmospheric condition are corrected using the histogram matching technique. Selective area filtering is applied to identify the extent of the selected stream reach where the change in water surface area is highly sensitive to the change in stream discharge. Following this, an iterative procedure called the Optimum Threshold Classification Algorithm (OTC) is applied to the multi-temporal selective areas to extract a series of water surface areas. It is observed that the extracted water surface area and the stream discharge are related by the power law equation. A strong correlation coefficient ranging from 0.68 to 0.98 (mean=0.89) was observed for thirteen hydrological stations, while at two stations the relationship was highly affected by the hydraulic structures such as dam. It is further identified that the availability of remotely sensed data for a range of discharge conditions and the geometric properties of the selected stream reach such as the stream width and side slope influence the accuracy of the flow estimation model.

Keywords : Discharge estimation, Stream, Water surface area, SAR

Acknowledgement

본 연구는 행정안전부 재난예측및저감연구개발사업의 지원을 받아 풍수해 직접-간접 피해를 고려한 피해 산정 및 예측 기술개발 과제에서 수행된 연구임 [MOIS-재난-2015-05]

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