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Exploring Sentinel-1 and Sentinel-2 diversity for Flood inundation mapping using deep learning

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Identification of flood water extent from satellite images has historically relied on either synthetic aperture radar (SAR) or multi-spectral (MS) imagery. But MS sensors may not penetrate cloud cover, whereas SAR is plagued by operational errors such as noise-like speckle challenging their viability to global flood mapping applications. An attractive alternative is to effectively combine MS data and SAR, i.e., two aspects that can be considered complementary with respect to flood mapping tasks. Therefore, in this study, we explore the diverse bands of Sentinel 2 (S2) derived water indices and Sentinel 1 (S1) derived SAR imagery along with their combinations to access their capability in generating accurate flood inundation maps. For this purpose, a fully connected deep convolutional neural network known as U-Net is applied to combinations of S1 and S2 bands to 446 (training: 313, validating: 44, testing: 89) hand labeled flood inundation extents derived from Sen1Floods11 dataset spanning across 11 flood events. The trained U-net was able to achieve a median F1 score of 0.74 when using DEM and S1 bands as input in comparison to 0.63 when using only S1 bands highlighting the active positive role of DEM in mapping floods. Among the, S2 bands, HSV (Hue, Saturation, Value) transformation of Sentinel 2 data has achieved a median F1 score of 0.94 outperforming the commonly used water spectral indices owing to HSV's transformation's superior contrast distinguishing abilities. Also, when combined with Sentinel 1 SAR imagery too, HSV achieves a median F1 score 0.95 outperforming all the well-established water indices in detecting floods in majority of test images.