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Multi-sensor optical remote sensing for generalized sub-metric detection of pluvial flood damages using U-net CNN and Random Forest.

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Pluvial floods (PFs) caused by extreme overland flow inland account for half of all flood damage claims each year, equally with fluvial floods (FFs). However, most remote sensing-based flood detection techniques only focus on the identification of degradations and/or water pixels in the close vicinity of overflowing streams. Geomatics hydrological models have been developed to easily and widely map susceptibility towards the occurrence of intense surface runoff without physics-based modelling. However, in order to increase confidence in such methods, they need to be comprehensively evaluated using PF observations from past events. For this, a generalized remote sensing fusion method called FuSVIPR (*Fusion of Sentinel-2 & Very high resolution Imagery for Pluvial flood detection in Runoff prone areas*) is developed. Based on 10 m change detection (from Sentinel-2) and sub-metric optical imagery (from *Pléiades* satellites and airborne sensors), machine learning (ML) and deep learning (DL) techniques are used to locate PF footprints on the ground at 0.5 m spatial resolution following heavy weather events. Post processing involving land use, soil type and topography allows accounting for runoff production processes to induce PFs downstream. In this work, six watersheds in the Aude and Alpes-Maritimes departments in the South of France are investigated over more than 3000 km^2 of rural and periurban areas during three flash-flood events between 2018 and 2020. With a unique learning sample from the Aude flash-floods of October 2018, overall detection accuracies greater than 86% and false detection rates below 7% are reached independently on all three distinct events. These results emphasize the high generalization capability of this method to locate PFs at any time of the year and over diverse regions worldwide. The resulting damage proxy maps have high potential for helping precipitation downscaling and thorough evaluation and improvement of surface water inundation models at very high spatial resolution.