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# Rapid mapping of landslides by Deep-Learning of combined optical and SAR data

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In the world, various natural calamities, like earthquakes and massive rainfalls sometimes combined with windstorms, can trigger multiple landslide events that can occur in groups of hundreds to thousands in a region, over a short time span. Therefore, there is a growing need to be able to intervene quickly to accurately map the impacted areas. To this end, VHR optical images ensure best performances in terms of spatial accuracy but, for rapid mapping, they present limitations due to the possible presence of cloud cover as, often, the first cloudless image is available with an unacceptable time delay, see, e.g., the cases of strong earthquakes of Chile 2017, Nepal 2015 and Ecuador 2016. A possible solution may stand in the combined exploitation of optical and SAR data. In this study, deep-learning convolution neural networks (CNNs) techniques have been used to compare and combine the mapping and classification performances of optical images (from Sentinel-2) and SAR images (from Sentinel-1). The training and test zones used to independently evaluate the performance of CNNs on different datasets are located in the eastern Iburi subprefecture in Hokkaido, where, at 03.08 local time (JST) on September 6, 2018, a Mw 6.6 earthquake triggered about 7837 coseismic landslides. We analyzed the conditions before and after the earthquake exploiting SAR and optical data by means of a series of CNNs implemented in Python that point out the locations where the *Landslide* class is predicted as more likely. As expected, the CNN run on optical images proved itself excellent for the landslide detection task, achieving an overall accuracy of 98.48% while a CNN based on the combination of ground range detected (GRD) data (SAR) achieved an overall accuracy of 95.54%. Despite this, the integrated use of SAR data allows for a rapid mapping even during storms and under cloud cover and seems to provide a comparable accuracy than optical change detection. We believe that, in the near future, such classification accuracy might even increase with the availability of new, VHR SAR products, such as the 50 cm x 50 cm resolution imagery from the Capella-2 satellite.