Towards a web service for rapid landslide mapping based on Copernicus data

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Abstract. Timely available landslide information is highly valuable for organizing emergency response activities and infrastructure restoration. The collection process for landslide information can benefit from the use of Earth observation (EO) data because they are capable of sensing potentially affected areas quickly and comprehensively. Challenges for an EO-based rapid landslide mapping service lie in developing a reliable and fast information provision process and in appropriate integration of landslide information products in the workflows and working environment of first responders. Our gap analysis for a developed pre-operational web service for EO-based landslide mapping identified a need to implement new components to meet these requirements. These comprise better linkage to the Copernicus data hub, increasing the degree of automation in the landslide information extraction process with machine learning technologies, and improving and testing user interaction with the service.

1. Introduction
Each year, landslides cause numerous deaths and significant damages in mountainous regions worldwide. Europe experienced 476 fatal landslides between 1995 and 2014 and had an average economic loss of 4.7 billion Euro per year [1]. A global documentation of landslides counted 55,997 fatalities in total from 2004 to 2016 and thereby emphasizes the global impact of landslides [2]. Information about landslides is a key issue to the entire cycle from disaster response over recovery and mitigation to preparation. An improved documentation of where landslides have occurred in the past allows better estimates where to expect future events, i.e. where mitigation and preparation is primarily necessary. In addition, information about landslide locations has to be timely available, if it shall be valuable in the disaster response phase [3]. Readily available landslide maps allow authorities to prioritize their emergency response activities to areas with the most severe problems. Additionally, they enable them to organize fast and efficient restoration of infrastructure.

During disaster response, authorities mainly collect landslide information by time-consuming and expensive in-field assessments and, if possible, by information from affected people. Earth observation (EO) data has a strong potential to support response operations after landslide events, because it is capable to sense potentially affected areas quickly and comprehensively. For some time, EO data is already used in emergency response. For example, authorities can trigger the Copernicus Emergency Mapping Service (EMS) that provides EO-based maps for different types of disasters. For landslides, however, only 17 EMS activations occurred since its start of operation in 2012 (as of August 2019).
Most of the time, floods were the cause for EMS activations, i.e. 120 times out of 344 activations in total.

2. Challenges and opportunities

A major challenge in rapid landslide mapping is the accurate and efficient information extraction from EO data. The appearance of landslides is very variable, the rough topography in mountainous areas brings difficulties (e.g. shadows, different illumination conditions), and clouds may be an issue especially when heavy rainfall caused the landslides. With the additional need for timely delivery, rapid landslide mapping requires a reliable and fast provision process that addresses all workflow components from EO data access and integration over image interpretation to landslide information delivery. Moreover, an appropriate integration of the information products into the workflows and working environment of first responders that use the data is essential.

In the research project Land@Slide (http://landslide.sbg.ac.at), we developed a pre-operational web service for EO-based landslide mapping that has the potential to evolve into a rapid mapping service for emergency response [4]. The web service can handle different types of optical EO data and allows users to extract landslide information interactively [5]. However, further development steps for strengthening the web service’s functionality for the rapid mapping use case are necessary. They comprise the linkage to the Copernicus data hub to speed up and ease the integration of Sentinel-1 and Sentinel-2 data and the use of tested automated algorithms for landslide information extraction. These requirements enable rapid mapping and effective documentation of areas affected by landslides. Such a development relies on big data management, web service functionalities for access to, integration of and processing of EO data and for the visualization of results. In addition, machine-learning technologies support the process for automating landslide detection and monitoring.

Apart from implementing these technologies, the service development requires an appropriate testing of user interaction with the service. In addition, we explore the commercial issues of such a service that allow it to become sustainable and operational.

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