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Editorial: Synthetic Aperture Radar and Natural Hazards: Applications and Outlooks

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Editorial on the Research Topic

Synthetic Aperture Radar and Natural Hazards: Applications and Outlooks

The ability of Synthetic Aperture Radar (SAR) to image the Earth's surface, even through dense cloud cover and in night-and-day conditions, can facilitate the evaluation and monitoring of natural hazards and the management of natural disasters. The family of SAR satellite sensors orbits the Earth at an altitude ranging from 500 to 800 km, following sun-synchronous, near-polar orbits, slightly inclined with respect to Earth meridians. The most commonly used bands in SAR applications are the C-band (5–6 GHz, ∼5, 6 cm wavelength), the X-band (8–12 GHz, ∼3, 1 cm wavelength), and the L-band (1–2 GHz ∼23 cm wavelength) with a temporal resolution depending on the satellite revisiting time. The availability of SAR has made a new spectrum of measurements possible on a global and spatial scale not attainable by ground-based studies, revealing critical insights into remote or poorly understood areas (e.g., Biggs et al., 2014). This Research Topics presents a review of articles on the state-of-art in the application of SAR sensors to study surface deformation in different geologic environments and triggered by a variety of processes. The topics discussed range from the analysis of co-seismic deformation (Merryman Boncori) to studies of volcanic unrest (Dzurisin et al.; Garthwaite et al.), monitoring of landslides (Bianchini et al.) and ground subsidence in urban areas (Solari et al.).

Merryman Boncori presents a review of the state-of-the-art concerning the co-seismic deformation measurement with space-borne SAR. SAR applications to over 100 case-studies since the launch of the SENTINEL-1A satellite are discussed, considering the performance of the different SAR sensors and data processing approaches. Although there has been a rapid spread of "free" software that allows DInSAR processing, there are only few systems able to carry out DInSAR processing of SENTINEL-1 data in an automated fashion. So, only few of the co-seismic deformation studies in the recent literature are based on automated processing chains. During the processing of a SAR data set, analysts must typically make several *ad-hoc* decisions, including what techniques to apply, which additional processing steps to include, and which approach to use for atmospheric corrections and phase unwrapping algorithms. All these issues are addressed in detail in this review.

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Dzurisin et al. review the current results of the U.S. Geological Survey SAR studies of volcanoes in the Aleutian (Alaska) and Cascades arcs (Oregon and Washington), in Hawai'i, and in the western U.S., including Yellowstone (Wyoming) and Long Valley caldera (California). This contribution summarizes findings in (1) the monitoring of volcanic deformation in remote areas of the Aleutian and Cascade arcs; (2) the use of SAR in hazard assessment during eruptions at Aleutian and Hawaiian volcanoes; (3) the identification of multiple magma storage zones beneath the summit area and along the East Rift Zone at Kilauea Volcano (Hawai'i); and (4) the tracking of the ascent of magmatic volatiles from a mid-crustal intrusion to shallow depth, and of increased hydrothermal activity at the surface of large calderas.

Garthwaite et al. propose a processing chain to integrate InSAR and Global Navigation Satellite Systems (GNSS) data to interpret deformation in a timely fashion and use this information as part of the decision-making process at volcano observatories. The case study presented to illustrate this approach is a joint modeling procedure that infers volume changes of a spherical source beneath the Rabaul Caldera (Papua New Guinea) using ALOS-PALSAR InSAR data and continuous GNSS data collected between 2007 and 2011.

Dumont et al. report how space-borne SAR observations have been integrated in the monitoring of the 2014–2015 Holuhraun eruption in the Bárðarbunga volcanic system (Iceland). SAR data were acquired during the unrest at Bárðarbunga caldera, the Holuhraun eruption and the year after the eruption by Cosmo-SkyMed (CSK) and TerraSAR-X (TSX) satellites. The remote sensing data were complemented by aerial SAR images as well. Monitoring of surface changes using both SAR amplitude and phase information was conducted to quantify and track the evolution of volcanic processes at Holuhraun and the geothermal activity at Bárðarbunga volcano. This contribution also discusses the operational importance of SAR information, that was regularly provided to the Icelandic Civil Protection and used in decision-making procedures.

Bianchini et al. and Solari et al. present two contributions that illustrate the transition from ERS/1 data to SENTINEL-1 data and the application of SAR to the monitoring of landslides and urban subsidence.

Bianchini et al. present a case study on the use of Multi-Temporal InSAR (MT-InSAR) for identifying and managing geo-hazards by a public administration. The article discusses the application of Persistent Scatterers InSAR over Tuscany (central Italy) in the past years, and the evolution of hazard maps from static pictures of the regional slope instabilities to dynamic images, with a regular and systematic 6-day acquisition plan. Tuscany has a leading role in Italy in the field of interferometric applications being the first region where InSAR analyses were performed at local basin scale by exploiting various PSI-based approaches for risk mapping and management. The local administrations supported the application of InSAR at a regional scale, first by using the archives of ERS and ENVISAT images to update subsidence and landslide inventory maps, and then by exploiting the regular repeat pass of SENTINEL-1 to identify the sites affected by the largest ground movements.

Finally, Solari et al. present a review on the applications of both DInSAR and MT-InSAR techniques to monitor ground subsidence in urban areas along the Italian Peninsula, where natural phenomena can be accelerated by anthropogenic factors. SAR ground deformation data can be used to increase the knowledge of the subsidence phenomena by mapping their spatial distribution, reconstructing their temporal evolution, and supporting groundwater management and urban development.

AUTHOR'S NOTE

All authors present a sintesys of the state of the art about the use of Synthetic Aperture Radar technologies in hazard mitigation and management in the world and introduce the contributions collected in the Research Topic.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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