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Unrest at Bárdarbunga: Preparations for possible flooding due to subglacial volcanism

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Located partly beneath northwest Vatnajökull, Iceland, the Bárdarbunga volcanic system comprises an ice-capped central volcano and a fissure swarm extending beyond the ice margin. During the last 1100 years the volcano has erupted on at least 26 occasions. Outburst floods (jökulhlaups) on a scale of >100,000 m3 s-1 are known to have occurred during major explosive eruptions. Repeated jökulhlaups from Bárdarbunga have inundated the Jökulsá á Fjöllum River, which drains over 200 km northwards from the Dyngjujökull outlet glacier to the north coast of Iceland. Depending on the location of the eruption within the 80 km2 caldera, jökulhlaups could also flow northwards along Skjálfandafljót River and towards west and southwest into present-day tributaries of the extensively hydropower-harnessed Thjórsá River.

On 16 August 2014, an intense earthquake swarm began within the Bárdarbunga caldera. Seismicity propagated from the caldera, extending ∼10 km northwards of the ice margin where a fissure eruption developed in late August and remains ongoing in early January 2015. In connection with the lateral migration of magma from the caldera, the ice surface of Bárdarbunga has lowered by over 60 m; also associated with increased geothermal heat on the caldera rim, as manifested by the development of ice-surface depressions.

In preparation for a subglacial eruption in the Bárdarbunga volcanic system, the Icelandic Meteorological Office (IMO) has made several assessments of likely hydrological hazards. Assessments were undertaken on Jökulsá á Fjöllum and Skjálfandafljót at key locations where preliminary evacuation plans for populated areas were made in cooperation with the local police. Floodwater extent was estimated for key infrastructures, such as bridges, telecommunication and power lines for maximum discharge levels ranging from 3,000 to 20,000 m3 s-1. The estimations were made using either simple Manning‘s calculations or HEC-RAS modelling.

Estimation of flood travel times within Jökulsá á Fjöllum and Skjálfandafljót were based on empirical observations of jökulhlaups elsewhere in Iceland. Map and reports featuring the assessment results have throughout the eruption been presented to the Department of Civil Protection and Emergency Management of the National Commissioner of the Icelandic Police, and to the public via IMO’s web-site (http://en.vedur.is/) and during public consultations.

In addition, IMO operates real-time monitoring of stage, discharge, conductivity and temperature at several hydrometric stations within the watersheds of Jökulsá á Fjöllum and Skjálfandafljót. This monitoring has been enhanced during the eruption with additional stations which all are programmed to give automated signal to the 24/7 duty at IMO if changes are observed in any of these parameters. It is of interest that no marked changes were observed in discharge or conductivity in Jökulsá á Fjöllum following the formation of subsidence cauldrons possibly caused by a minor subglacial eruption on 23 August.

Preparations for a possible jökulhlaup from Bárdarbunga continue in line with the evolution of the fissure eruption and a possible subglacial eruption in or around the caldera.