Sourced from within the volcano’s ice-filled caldera, the April 2010 eruption of Eyjafjallajökull caused repeated glacial floods (jökulhlaup) in response to initial subglacial volcanism, followed by phreatomagmatic activity and lava-flow confined by ice. Here we constrain the timing, routing and intensity of jökulhlaups during the 39-day eruption, focusing on flood processes, sediment deposition and hydrological hazards. Our analysis is based on (i): hydrological measurements; (ii) aerial and ground-based imagery; (iii) topographic data from an airborne LIDAR survey; (iv) airborne synthetic-aperture radar; and (v) continuous measurements of seismic tremor during the eruption. Rising to ~1,640 m a.s.l., the summit caldera of the Eyjafjallajökull stratovolcano, southern Iceland, is infilled with up to 150 m of ice, which forms Gígjökull - a northward flowing valley glacier. The summit eruption began at 01:15 UTC on 14 April; consequently, flood evacuation orders were issued to over 800 inhabitants in the vicinity of the volcano. By 06:45, stage measurements 1 km from Gígjökull confirmed the onset of flooding. Gauged 18 km downstream from Gígjökull, the initial jökulhlaup reached a discharge of 2,700 m3/s within 88 minutes of arrival. A smaller, concurrent jökulhlaup also burst from the southern flank of Eyjafjallajökull, carving a 3-km-long trench into the ice surface. On both sides of Eyjafjallajökull, sediment-laden floodwater damaged infrastructure and inundated farmland. Large quantities of comminuted ice and juvenile material were deposited by repeated jökulhlaups between 14 and 16 April, with flood properties, routing and intensity varying in response to the changing nature of the eruption.