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# Why the Icelandic volcano eruption could herald more disruption

Dr Andrew Hooper of Delft University

The unprecedented no-fly zone currently in force across much of Europe has already caused the greatest chaos to air travel since the Second World War. Thousands of flights have been cancelled or postponed with millions of travel plans affected. It has been estimated that shutting down the UK's airspace alone over the weekend could cost airlines over 100 million pounds, with the share price of some leading airlines already taking a hit.

The wider economic consequence to our 'just-in-time' society is incalculable at this stage given the disruption to holidays, business plans and indeed the wider business supply chain. However, the global cost of the disruption will surely ultimately result in a cost of billions rather than hundreds of millions of pounds.

It is exceptionally hard to gauge how long the current grounding of flights will remain in force, although Eyjafjallajökull, the Icelandic volcano which has erupted, could potentially sputter on for months or even more than a year. Much could depend upon weather patterns, especially wind direction, over the next few days.

The worst-case scenario in terms of precedent here is the 1783-1784 eruption at Laki (a very large eruption of 14km<sup>3</sup> compared to the one in Mount St. Helens in 1980 of 1 km<sup>3</sup>) that had a huge impact on the northern hemisphere, reducing temperatures by up to 3 degrees. This led to catastrophe far beyond the shores of Iceland (where 25% of population died), with thousands of recorded deaths in Britain due to poisoning and extreme cold, and record low rainfall in North Africa.

By contrast, the eruption of Eyjafjallajökull in 1821-1823 (when only about 0.1km<sup>3</sup> was erupted) had little impact beyond the shores of Iceland, where livestock were killed by flourine poisoning. Like 1821-1823, this current eruption is likely to remain small in terms of volume, but in an age of mass aviation, a relatively small amount of erupted ash is having huge consequences.

One volcanic eruption in Alaska in 1989 necessitated the postponement and cancellation of flights in North America for days. It is likely that the fallout from the volcanic eruption yesterday will be worse because European airspace is more congested than in North America for global airline traffic.

How much material will be erupted? Observations of surface deformation can throw light on this. These come principally from two sources — the first being a handful of GPS receivers dotted around the volcano by the University of Iceland and the Iceland Met Office, and the second being imaging radar on board satellites.

Differencing of subsequent radar images can give surprisingly accurate maps of the movement of the ground. I and others at Delft University of Technology have been developing algorithms to push the limits of the technique, to extract measurements from radar data in regions where it is more difficult, and with greater accuracy.

The usual pattern with Icelandic eruptions is for rising and stretching of the surface as magma moves up to shallow depths of a few kilometres, followed by contraction and sinking of the surface as magma exits the shallow magma chamber and erupts at the surface.

However, in this case, Delft University working in collaboration with the University of Iceland has detected magma moving upwards until the onset of the initial eruption on March 20th, but very little deformation since then. This implies that the volume of erupted magma is balanced by new magma coming from deep within the crust, perhaps even the crust mantle boundary, and it is impossible to

know how much magma may be stored at these depths. Thus, it remains a very real possibility that the volcano will continue to erupt on-and-off for months to come, as occurred during the last eruptive period in 1821-1823.

Measurements of the surface deformation, together with detected earthquakes, have indicated magma rising to shallow depths since the beginning of this year. Questions have been raised why an eruption was not predicted beyond the time scale of a couple of hours prior to initiation.

From analysis of radar data we know of two events at Eyjafjallajökull in 1994 and 1999, that started in a similar way with magma moving to shallow depths (5-6 kilometres). However, in both cases the magma then spread out laterally and remained in the crust. Apparently something differed this time in that stress conditions favoured continued migration of the magma upwards. We have some way to go before we can answer what seems like a simple question, whether magma moving upwards to shallow depths is likely to erupt, or stall within the crust.

At the end of the last ice age, the rate of eruption in Iceland was some 30 times higher than historic rates. This is because the reduction in the ice load reduced the pressure in the mantle, leading to decompression melting there. Since the late 19th Century the ice caps in Iceland have been shrinking yet further, due to changing climate. This will lead to additional magma generation, so we should expect more frequent and/or more voluminous eruptions in the future.

Eyjafjallajökull is a relatively small volcano and unlikely to erupt the volumes of material that will have a significant impact on climate. However, eruptions of Eyjafjallajökull in 1821-1823 and 1612 were followed in short shrift by eruptions of its much larger neighbour, Katla.

Katla thus has shown the potential for large eruptions in the past — the last catastrophic Icelandic eruption prior to Laki was from Katla in 934 when an even greater volume of lava was erupted. If Katla were to erupt in a significant way, the potential for travel chaos and economic damage would thus be much greater than has occurred in the last 24 hours.

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