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Volcanic ash and aviation: Recommendations to improve preparedness for extreme events

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ABSTRACT

The eruption of the Eyjafjallajökull volcano in 2010 was an unprecedented event for European aviation and emphasized the need for advancements in the corresponding risk management of the stakeholders involved. This study researches progress since 2010, as significant regulatory changes have been introduced to improve European and North Atlantic aviation risk management with regards to volcanic ash. A participatory stakeholder workshop with scenario narratives was set up in which stakeholders discussed obstacles in the general management of aviation during volcanic ash eruptions as well as under extreme eruption scenarios. This paper presents recommendations developed from the workshop.

The research found that a better understanding is needed of the impacts that long lasting ash episodes may have on aviation. Events of long duration require improved availability of staff, e.g., with staff exchange between related agencies. Furthermore, it is recommended that staff be trained to meet accelerated demands and restructured tasks during a crisis that may last for months. It is also suggested that more challenging response exercises be used to drive stakeholders out of their comfort zone.

The study provides recommendations on information exchange between the stakeholders. During an event, the large amounts of information received from scattered sources may be quite challenging. A single point of information for stakeholders could be set up to structure the information and reduce confusion. Communication products, such as maps, must be better aligned with end-user needs. Ensuring the comprehensibility of difficult features, such as the representation of uncertainty in ash distribution modelling and produced data, requires discussion with end-users prior to an event.

The study stresses the need for further funding of research on the impact of ash on jet engines since lack of knowledge in this area limits the benefits of advances in ash forecasting. The application of the Safety Risk Assessment approach needs to be coordinated across nations.

Abbreviations: ATFCM, Air Traffic Flow and Capacity Management; ANSP, Air Navigation Service Provider; AO, Aircraft Operator; ATC, Air Traffic Control; E2010, Eyjafjallajökull volcano eruption in 2010; EACCC, European Aviation Crisis Coordination Cell; ENHANCE, European Project on Partnerships for Disaster Risk Reduction; EUR/NAT, European and North Atlantic airspace; EUROCONTROL, European Organization for the Safety of Air Navigation; EVITA, European crisis Visualisation Interactive Tool for ATFCM; FL, Flight Level; HYSPLIT, Hybrid Single Particle Lagrangian Integrated Trajectory Model; IATA, International Air Transport Association; ICAO, International Civil Aviation Organization; ICETRA, Icelandic Transport Authority; IMO, Icelandic Meteorological Office; IRR, Icelandic Ministry of the Interior; ISAVIA, Icelandic Air Traffic and Airport Management Corporation; IVATF, International Volcanic Ash Task Force; MSP, Multi-Sector Partnership; NAME, Numeric Atmospheric Modelling Environment, ash dispersion model; NASA, U.S. National Aeronautics and Space Administration; NORDRESS, Nordic Centre of Excellence on Resilience and Societal Security; SRA, Safety Risk Assessment; VAAC, Volcanic Ash Advisory Centre; VOLCEX, Volcanic Ash Exercise organized by ICAO to rehearse initial response to volcanic ash eruption; VOLCICE, Monthly information flow practice between IMO, ISAVIA and London VAAC; WMO, World Meteorological Organization

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Strengthening society's resilience as a whole to such events, calls for a comprehensive long-term contingency plan, including alternative transportation if aircrafts are grounded.

1. Introduction

During eruptions, volcanoes can emit a diverse range of material such as lava, tephra, and gas. The matter of greatest concern to aviation is volcanic ash. Its chemical and physical composition makes volcanic ash a highly abrasive material that can harm the surface of an aircraft as well as the jet engines (Casadevall, 1993). Volcanic ash consists of small, light particles that can travel several thousand kilometers from the source volcano and, depending on the initial height of the ash column produced by the volcano, can be found in all flight levels (Casadevall, 1994).

After the first aviation incidents with engine failure caused by volcanic ash, the International Civil Aviation Organization (ICAO) developed precautionary guidelines to mitigate exposure to the hazard. Aviation safety rules ensure the avoidance of airspace that is contaminated with volcanic ash concentrations that threaten loss of engine power (ICAO, 2012a).

While the precautionary approach ensures aviation safety, avoidance of airspace can cause immense economic damage through, at times costly, rerouting or cancellation of flights if rerouting is not an option. The ash from a volcanic eruption in Iceland has the potential to interfere with heavily used intercontinental flight corridors for goods and passengers, impacting economies worldwide. A case in point is the Eyjafjallajökull eruption in April 2010 (hereafter termed E2010). More than 100,000 flights were cancelled, more than 10 million passengers were affected and there was an estimated 5 billion USD in global economic damage (Bye, 2011). E2010 revealed the vulnerability of global interconnectedness through air traffic as described by Birtchnell and Büscher (2011).

E2010 further highlighted the need for coordination in the air transportation sector in Europe. With no preexisting central response coordination structure in place, EUROCONTROL, the European Organisation for the Safety of Air Navigation, took a coordinating role in the crisis (Bolić and Sivčev, 2011). It facilitated discussions to replace the precautionary approach of general airspace closure and to introduce a more refined risk approach.

In agreement with jet engine experts, the lower threshold for ash concentration was raised and new ranges of ash concentration levels were determined to divide airspace into low, medium and high levels of ash contamination. This allowed airspace to be reopened in areas contaminated with low levels of ash concentration and partly reopened in medium level ash concentrations (Bolić and Sivčev, 2011).

Subsequently, the European Aviation Crisis Coordination Cell (EACCC), with representatives from the European aviation network, was created under EUROCONTROL to formalize a coordination body during crisis situations.

E2010 further prompted a paradigm shift in the management of volcanic ash and aviation in Europe. In the aftermath of E2010, a regulatory change was initiated to shift the decision making from State aviation authorities to airline operators. Prior to E2010, European states would close airspace that was forecasted to be contaminated with volcanic ash (Bolić and Sivčev, 2011). Under the new procedure, European airspace would, with exceptions, remain open. The decision on whether to fly would be made by the aircraft operators, conditional on a Safety Risk Assessment (SRA) of the airline having been accepted (ICAO, 2012a).

The SRA describes the procedures which an aircraft operator follows when operating in airspace forecasted, or known, to be contaminated with volcanic ash. The SRA has to be completed and evaluated by the operator's State Civil Aviation Authority prior to

Table 1
Aviation stakeholders - overview of sectors, roles, and example of institutions in the study.

Sector	Role in volcanic ash management	Institutions
Global air regulator	Development of global standards and recommended practices	ICAO (International Civil Aviation Organization)
International regulator	Limit setting for shared air transportation zones	EU Directorate General for Mobility and Transport
International facilitator	Representative of airline industry, formulate industry policy on critical aviation issues	IATA (International Air Transport Association)
National regulator	Responsible for state's Volcanic Ash Contingency Plan, approval of Safety Risk Assessment procedures, airspace closure	ICETRA (Icelandic Transport Authority)
National regulator	Supervision of ISAVIA and ICETRA, resource allocation to fund extra costs, policies regarding risk management (e.g., transportation plans)	IRR (Icelandic Ministry of the Interior)
Crisis coordination and network management	Network management and crisis coordination response	EUROCONTROL (European Organisation for the Safety of Air Navigation)
Information provider	Issue weather observations and forecasting. Monitoring of volcanic eruption, detection of seismic activity, ash measurements, issue warnings	IMO (Icelandic Meteorological Office)
Information provider	Tracks volcanic activity and issues ash distribution forecasts	London VAAC (Volcanic Ash Advisory Centre)
Information provider	Engine manufacturer, guidance on engines for airlines and information for national governments, European Aviation Safety Agency	Rolls-Royce
Air navigation service provider	Management of airport operations and air traffic in control area	ISAVIA (Icelandic Air Traffic Management)
Aircraft operators	Air transportation and service providers to passengers and cargo	Icelandair (Icelandic Aircraft operator)