Volcanic tsunami warnings – insights from the International Airways Volcano Watch

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Introduction

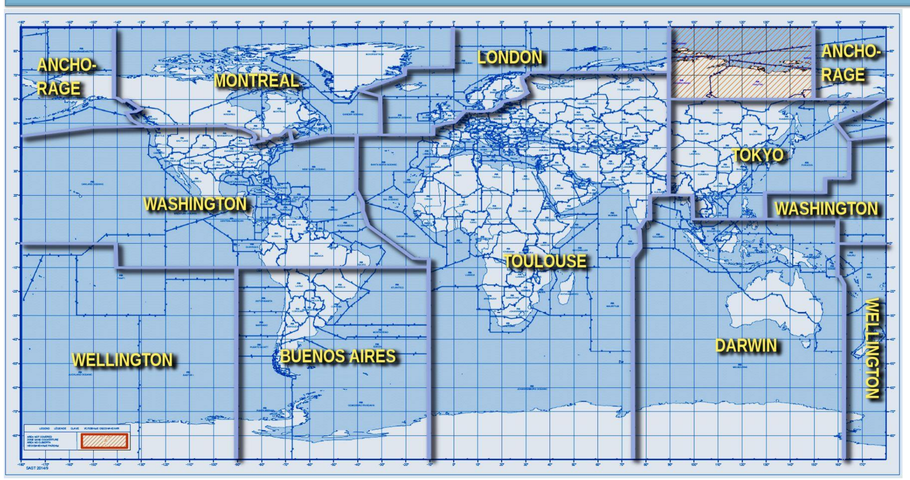
Volcanoes are the second-most common source of historical tsunami after earthquakes, but volcanic tsunami are not necessarily well accounted for in global tsunami warning systems, although local arrangements exist in some areas, such as for the Augustine volcano in Alaska[1]. International arrangements for volcanic ash warnings for aviation may be relevant in addressing this issue.

The International Airways Volcano Watch[2] was established in 1993 following several serious in-air incidents in the 1980s and early 1991s. It is administered by the International Civil Aviation Organization (ICAO), with science advice from the World Meteorological Organization (WMO). The system brings two scientific professions (volcanology and meteorology) together with real-time aviation users. Since the eruption of Iceland's Eyjafjallajökull in 2010, further extensive improvement efforts have been made by the International Civil Aviation Organization, World Meteorological Organization, science community and aviation partners in the system. Despite this, serious incidents can and do continue to occur, particularly in areas where volcanoes are not intensively monitored and warnings of impending eruptions are not possible. The most recent documented ash-induced all-engine failure occurred in July 2006 over Papua New Guinea, when a Gulfstream on survey work lost power to both engines, but was able to restart them at lower altitudes.

Insights for tsunami warning

The International Airways Volcano Watch:

- is a tiered warning system for aviation that uses output from specialist advisory centres (Volcanic Ash Advisory Centres) to guide national warnings and decision making
- brings meteorological & geological sciences together in the context of rapid response, high profile and high consequence hazard warnings (*as well as ongoing, chronic, but less severe hazard situations)*
- is challenged by variations in national and international observations, communications and response capabilities
- requires extensive operational and scientific diplomacy to maintain and develop
- requires rapid, accurate information from volcano observatories to function well



Left; the International Airways Volcano Watch has nine Volcanic Ash Advisory Centres (areas of responsibility shown in the foreground) that, using volcanological advice, ground, air, and space-based observations, and ash dispersion modelling, give advice on location and expected movement of volcanic ash to State-based aviation and air-traffic control centres (areas of responsibility shown in the background). Courtesy ICAO and Météo-France.

Working with volcano observatories

Volcano observatories are relatively loosely organised compared to operational meteorology and the aviation industry, both of which have specialist UN organisations to assist in coordination. Historically, the strongest international connections among volcanological agencies have occurred through individual relationships and through partnership efforts between agencies. For example, for many years, the United States Geological Survey has worked closely with volcanological agencies in Russia, Central and South America, and southeast Asia. Much of this work has relied on dedicated individuals, assisted by institutional support and aid sources (such as USAID). At UN level, WMO and ICAO have invited the International Union of Geodesy and Geophysics (IUGG), through its member association, the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI), and IAVCEI's World Organisation of Volcano Observatories (WOVO) to have a representative on relevant bodies. Following the Eyjafjallajökull crisis, ICAO has also introduced a stronger ***requirement*** on member States for improved volcanic monitoring, through the operations of the Convention on Civil Aviation. These arrangements also seek to recognise the importance of integrating relevant arrangements for other hazards such as tsunamigenic volcanic eruptions (see below). This may give an opportunity to improve global arrangements for warning of potential tsunami from volcanic eruptions.

Right: Sangeang Api eruption, Indonesia. 30 May 2014. Photo by Sofyan Effendi (Getty Images).

ICAO's requirements on States

ICAO requires States responsible for flight information regions in which there are active or potentially active volcanoes in proximity to routes used by international flights to, amongst other things:

a) instrumentally and visually monitor those volcanoes, with appropriate resourcing and a quality management systems approach, and

b) establish and use systems and channels of communication for sharing observations, and share 24/7 contact information.

ICAO's documentation also notes that States should assist each other and '*consider the above as part of an integrated suite of arrangements for other related volcanic hazards, such as ashfall on airports, populated areas and agricultural zones, shipping hazards, volcanic tsunami, and rainfall that may induce dome collapse, lahar activity or slope failure'* [3].

An ICAO requirement does not mean instant conformance, and can only be formally mandated in regard to aviation matters. It may, however, present a good opportunity to 'piggyback' arrangements for potentially tsunamigenic volcanoes onto this evolving structure. In order to effectively do that, agreed science and operational requirements for volcanic tsunami warnings would be an advantage.

Conclusions and potential next steps

The strengthening of aviation-related requirements on volcano observatories may present an opportunity to promote better volcano observatory information for tsunami warning purposes, so that international warning systems can be developed in a sympathetic manner. A key step would be to determine what scientific information is needed from an eruption scenario as input to a tsunami warning scenario and how this could be delivered timely and routinely in an operational setting. Existing localised arrangements, such as described for Augustine, together with the experiences of international volcanic ash and (seismically-focused) tsunami warning systems, could be used to inform discussions towards this end.

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References

1. Neal et al., 2010, *Hazard Information Management, Interagency Coordination, and Impacts of the 2005–2006 Eruption of Augustine Volcano* ,in The 2006 Eruption of Augustine Volcano, Alaska, USGS Professional Paper 1769, http://pubs.usgs.gov/pp/1769/
2. Guffanti & Tupper, 2015, *Volcanic Ash Hazards and Aviation Risk*, in Volcanic Hazards, Risks and Disasters, Papale & Shroder (eds), Springer
3. International Civil Aviation Organization, 2015, Handbook on the International Airways Volcano Watch.,Doc 9766 — *Handbook on the International Airways Volcano Watch (IAVW)*. Available via http://www.icao.int/safety/meteorology/iavwopsg/Handbook%20on%20the%20IAVW%20Doc%209766/Forms/AllItems.aspx .