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# Risk, interest groups and the definition of crisis: the case of volcanic ash

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# Risk and the Dilemmas of Regulation: The Case of Volcanic Ash

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High profile crises regularly prompt debate about the adequacy of regulation and the need for regulatory reform. Two recent examples are the financial crisis which became evident in 2007 and the damage to the Fukushima nuclear facility in 2011. The growing trend to blame the regulators exemplifies a key aspect of the 'risk society' thesis: the belief that we should be able to manage risks and control the world around us (Beck 2006; Bernstein 1996; Giddens 1999). Crises and disasters are amongst the most extreme challenges to risk regulation systems. Events precipitated by the April 2010 volcanic eruption in the Eyjafjallajökull area of Iceland are widely described as a major crisis. The resulting cloud of volcanic ash spread across Europe and much of Europe's airspace was closed to civil aviation for six days, with far reaching consequences including huge financial losses for airlines. Our concern here is not what can be learnt from such events about risk or safety, but what can be learnt about regulation itself[1] and why unrealistic expectations often appear to be placed on regulatory bodies in contemporary society. We argue that a sociological understanding of regulation requires an appreciation that regulation and the debates and conflicts surrounding it are embedded in - indeed created by - social and cultural environments. The social processes of defining and reacting to risk and crisis both reveal and generate dilemmas and challenges in regulation. We focus on the interface between risk and risk events as socially constructed and the insights that 'critical situations' give us into 'the routine and mundane' (Giddens 1979: 127), the otherwise taken for granted assumptions underlying risk regulation.

**Keywords:** risk, regulation, crisis, interest groups, volcanic ash, science

## Risk regulation: context and dilemmas

Contemporary regulation has evolved over an extended period of unrelenting scientific development and of economic, social and political change. Since its emergence as a

regular means of the state controlling economic activities in Western societies in the late nineteenth Century, the scope and organisation of regulation has transformed, as has the rhetoric surrounding it. Regulatory bodies have proliferated, but contemporary regulation is no longer the preserve of the state. Insurance companies, industry associations, businesses, non-governmental organizations and the media have all become invested with the power to influence regulatory decision-making (Black 2002; Grabosky 2012). The interdependence of regulatory bodies, other organisations, politicians and experts creates tensions that, we suggest, are not always well understood. Further interrelationships follow from government initiated changes in the past decade such as the marketisation of state-owned bodies in the UK (Lawless 2011a) and the trend to proliferate layers of regulation.[2] These processes have the potential to set up competing interests and blocks to information flow within as well as between organisations, with consequences for regulation that may not have been fully anticipated but may be exposed at a time of crisis.

The traditional objects of state regulation were manufactured risks, most particularly those resulting from scientific and technological innovation - the risks Beck (2006) 'warns' of as leading to potentially catastrophic global risks. Early regulation was typically directed at managing man-made risks emanating from manufacturing processes. The more recent growth of financial regulation is similarly concerned with man-made risks. Increasingly however regulation is seen as a tool for mitigating the risks associated with natural disasters,. Indeed, the recent literature on disasters recognises that natural and man-made risks are interwoven and interact (Perrow 2007). The repercussions of natural events may resonate across national boundaries in a world where the local and the global are ever more interconnected (Beck 2009). The 2010 Eyjafjallajoekull volcanic eruption, the focus of this paper, is potentially revealing as a natural event with worldwide repercussions that

exposed our reliance on technical developments. The eruption did not result in any injuries or fatalities, but it caused major disruption to air transportation of passengers and also goods and services.

Contemporary regulatory approaches are dominated by concepts of risk. Risk regulation, both within and beyond the state, is concerned with the anticipation of what could happen, aiming to reduce actual harm by anticipation and prevention. It is explicitly designed and discussed in terms of systematic risk assessment, and prioritization (Black 2005; Hutter 2005; Power 2007). As risk has become central to the rhetoric of regulation, dilemmas that are an inescapable part of the regulatory world have become more exposed. Values and ambitions compete within society, and the interests prioritised in regulation are contested. Risk-based approaches systematise and therefore make explicit the processes of defining, measuring and weighting risks, and the choices involved in targeting regulation are thrown into relief. At a macro level the form and content of regulatory law, as with any system of legal rules, reflects the dominant ambitions and values of a society at specific times. Regulation has embodied such values as protecting human life, protecting the environment, promoting particular conceptions of fairness, protecting particular forms of commerce and financial stability.[3] At the same time, it reflects society's ambivalence. Regulation involves choices about how social and economic costs and benefits are to be distributed; and about the role of the state in promoting certain interests, particular conceptions of equality or inequality, or freedom versus restriction of trade. In choices about which risks to regulate, what relative value is to be given to individual or collective goods or to the benefits of scientific and technical endeavours versus the costs? Regulation is, in short, inextricably embedded in issues of political legitimacy and economies that demand risk taking (Haines 2011). At a more grounded level, policy makers in

governments and in private and public sector organizations need to balance delicately a whole series of decisions about the evidence of risk, how to respond, to what extent to respond, how much uncertainty is acceptable and what levels of risk are tolerable. The word 'regulation' is apt, as it conveys management not elimination of risk. It is about control and restriction but also adaptation and flexibility. Governments need to decide whether, through risk regulation regimes, to interfere 'with market or social processes to control potential adverse consequences to health' (Hood, Rothstein and Baldwin 2001). Regulators need to decide how to implement legislation both at a policy making level and also at ground level enforcement. 'Appropriate' levels of risk regulation are sometimes negotiated by the state in conjunction with interested groups. In other cases, the state remains at a distance and regulation is exercised by either economic or civil society actors.

The politics of managing the tensions and interests involved in risk regulation are well demonstrated in the language of political debate and critiques of government policy. Risk regulation has never been solely a technical matter: it involves difficult political and ethical decisions about priorities and balance rather than absolute choices. For the reasons outlined above, regulation is continually surrounded by normative rhetoric and debate, sometimes ferocious. Indeed, a cynical view of regulatory agencies is that they were in part state creations designed to relieve governments and politicians of difficult and contentious decisions, and assign them to regulators who take responsibility and also take the blame at times of crisis (Douglas 1992). More recently, Hutter (2005) suggests that one reason risk-based regulation in particular is attractive and endorsed by governments is that its definition remains vague. What are essentially moral choices can be given a spurious objectivity and precision. Again, the tensions and dilemmas embedded in regulation may be exposed by crises.

**The volcanic ash case**

The remainder of the paper draws on the events surrounding the 2010 Eyjafjallajoekull volcanic eruption, and the crisis that ensued as volcanic ash spread across Europe bringing aviation to a standstill. Our analysis centres on the UK's civil aviation regulator, the Civil Aviation Authority (CAA). However, the interdependence of relevant regulatory bodies, other organisations, politicians and experts requires a much broader focus. As well as other bodies concerned with the regulation of aviation, we also consider the interest groups that became involved and the role of 'scientific' information before and during the crisis. Eyjafjallajoekull is widely referred to within the CAA and elsewhere by the numeronym E15 and we adopt this as convenient shorthand.

*Research questions, data and materials*

The central question for our analysis is: how do the organisational structure, powers, political position and remit of the CAA reflect contemporary regulation and society, and what, in turn, were the effects on responses to the crisis? More specific questions are organised around 1) the existing regulatory and political context into which the events intruded, and the existing state of information and regulatory policy regarding volcanic ash and aviation; and 2) the evolving processes of defining and responding to a crisis. Crises are to some degree socially constructed: they unfold and come to be realised as crises. How did the crisis unfold for the CAA and how did they respond? How did the CAA's understandings and responses intertwine with the responses of other regulatory bodies, the media, politicians, or other interested parties? What factors shaped social

perceptions of the crisis? The longer term processes of learning and adjustment in the wake of the crisis are still being played out and are not considered in this paper.

These questions were examined using a combination of face to face interviews and analysis of relevant documents. Data sources include:

1. Press coverage of the crisis from 15 to 30 April 2010;

2. Examination of internal documents relating to the CAA and the crisis before, during and after the closure of air space; provided by the CAA;

3. Examination of publicly available documents relating to the CAA and the crisis before, during and after the closure of air space, gathered through internet search;

4. Interviews with staff at senior policy level within the CAA, the Met office, the Irish Aviation Authority (IAA) and two airlines;

5. Academic and specialist comment on the event and its aftermath.

**Findings**

**1. Existing context and the anticipation of risk**

*The CAA and other organisations involved in the regulation of UK air space and ash-related decisions*

The existing context illustrates many facets of contemporary UK regulation. The **CAA** is a public corporation whose responsibilities include ensuring compliance with Britain's aviation safety standards,[4] placing it at the centre of the stage during the E15 eruption. It

was originally established by Parliament in 1972 as an independent specialist aviation regulator and provider of air traffic services. While its constitution and functions are conferred by Act of Parliament it is sponsored by the Department of Transport, whose Secretary of State is accountable to Parliament for the CAA's proper discharge of its duties.[5] Its costs must be met entirely from its charges on those whom it regulates – there is no direct government funding of its work.[6] In this respect the present structure exemplifies the process of marketization, which expects state-owned enterprises to act like market-oriented firms and operate according to commercial criteria. The CAA must also manage its public profile, and it must respond to wider political demands and pressures. Its remit can be unclear at the margins and is subject to change. In these respects it is typical of regulatory bodies, both state and non-state. In addition, given the nature of modern aviation it operates in an international arena more than many other UK regulatory bodies, coordinating closely with numerous European and other international bodies concerned with the regulation of aviation.

In common with other regulatory bodies, the CAA operates within a network of organisations and bodies on which it relies for information and expertise; with which it must manage interactions; and with which it may become entangled in blame games.[7] Bodies the CAA must interact with include **NATS** (NATS (En Route) Plc, formerly National Air Traffic Services Ltd) and the Met Office (formerly the Meteorological Office). NATS was part of the CAA from 1982 to 2001. The CAA was responsible under the Civil Aviation Act 1982 for providing are traffic services, and NATS was established as a wholly publicly owned corporation within the CAA to fulfil this role. In 2001, under a controversial Public-Private Partnership deal, NATS became jointly owned by the Government, a consortium of airlines and its staff.[8] It is now a commercial enterprise that

charges airlines fees for providing its air traffic control services, and it is regulated by the CAA. It manages air traffic destined for and leaving from the major UK airports and also provides en route navigation services for air traffic passing through UK airspace.

The **Met Office** is the UK's national weather service, providing a growing range of weather and climate services. It is a Trading Fund[9] within the Department for Business Innovation and Skills (BIS), operating on a commercial basis under set targets. Originally established in 1854 as a small department within the Board of Trade as a service to mariners, it became an executive agency (or 'next step' agency) of the Ministry of Defence in 1990, and then, following a 'machinery of government' change, moved to BIS in 2011. As part of its aviation forecast operation the Met Office operates the **London Volcanic Ash Advisory Centre** [VAAC]. The London VAAC is one of nine global VAACs and is responsible for the area covering the British Isles, the north east Atlantic and Iceland. VAACs are a worldwide network providing forecasts to the aviation industry of volcanic ash clouds that could enter aircraft flight paths The information is used to reroute flight paths around any area of contamination. The VAACs were set up in 1987 by the **International Civil Aviation Organisation** [ICAO] as part of the **International Airways Volcano Watch** (IAVW). ICAO is a specialised agency of the United Nations, created in 1944 to promote safe international civil aviation throughout the world. It sets standards and regulations and it serves as the forum for cooperation in all fields of civil aviation among its 190 Member States.

In addition to these UK based and international organisations, a number of European organisations were directly involved in responding to the ash incident. The most important of these are **Eurocontrol** and the **European Aviation Safety Agency** (EASA) created in

2002. Eurocontrol is an intergovernmental organisation made up of 39 Member States and the European Community. Founded in 1960, it is a civil-military organisation that develops European air traffic control and airspace regulations and procedures.[10] Amongst its roles is the day-to-day co-ordination of air traffic control across member states through the Central Flow Management Unit (CFMU); and crisis management largely through ensuring dissemination of information. EASA is the EC body responsible for European civil aviation regulations and also for certifying airframes and engines.

Most of the various bodies mentioned above make broad mission statements and state goals on their web sites in terms of such values as safety and environmental and consumer protection. The CAA, for example, states: 'The CAA works to ensure that risks to consumers are minimized and that passengers are aware of their rights'[11] and 'The CAA works closely with the EASA to promote the highest common standards of safety and environmental protection in civil aviation'.[12] EASA describes its mission as the promotion of standards of safety and environmental protection in civil aviation both in Europe and worldwide. The political context in which they operate is also reflected in the values and strategic goals explicitly endorsed by many of these organizations. Amongst the CAA's strategic objectives, for example, is 'Improving choice and value for aviation consumers now and in the future by promoting competitive markets, contributing to consumers' ability to make informed decisions and protecting them where appropriate'; and ' Ensuring that the CAA is an efficient and effective organisation which meets Better Regulation principles'. The public faces of NATS and the Met Office are more clearly dominated by commercial goals and the need to sell their wares. For example, the Met Office states: 'As a world leader in providing weather and climate services, we … are recognised as one of the world's most accurate forecasters, using more than 10 million

weather observations a day, an advanced atmospheric model and a high performance supercomputer to create 3,000 tailored forecasts and briefings a day. These are delivered to a huge range of customers from the Government, to businesses, the general public, armed forces, and other organisations.'[13] NATS summarizes its vision as 'To be the acknowledged global leader in innovative air traffic solutions and airport performance'.[14] Elsewhere a headline is: 'The peace of mind you're looking for'.[15] Eurocontrol expresses political values of European unity and co-operation, for example: 'We play a pivotal role in Europe by working together with all aviation partners to deliver a Single European Sky that will help to meet the safety, capacity and performance challenges of European aviation in the 21st century'.[16]

Further relevant groups and international dimensions came to the fore during the crisis, and some of these are mentioned below. The network of relevant organisations is overlaid with numerous working groups and committees, often with common membership cutting across different bodies; formal as well as informal channels of communication; and personal connections.

*Existing knowledge and policy regarding volcanic ash*

By 2010 the potential danger to aircraft from flying through volcanic ash was well recognised worldwide. The VAACs were established following serious ash incidents in the 1980's. One of the best known occurred in 1982. A British Airways Boeing 747-200, with four Rolls-Royce RB-211 jet engines entered a volcanic ash cloud from the erupting Indonesian volcano Gulunggung. Within a few minutes, all four engines failed. In a second widely cited incident in 1989, KLM Flight 867 flew through the plume from

Mount Redoubt. Fortunately in both incidents the pilots were able to recover at least some of their engines after descending several thousand feet, and eventually land safely.

In April 2010 internationally accepted procedures were in place to respond to ash clouds by gathering and communicating information to the aviation community and rerouting flight paths.[17] This involves several stages. The VAACs are responsible for issuing volcanic ash advisories to State flight information centres and Meteorological Watch Offices (MWOs). The MWO then has the responsibility for producing volcanic ash 'significant meteorological information'(SIGMETs) for that state's Flight Information Regions (FIRs). It is up to the state's aviation authorities to decide whether the aviation community is further informed through NOTAMs (Notice to Airmen) or ASHTAMs.

Most of the contingency plan applicable to the E15 event came out of an eruption of another Icelandic volcano, Grímsvötn, in 2003-4. The eruption lasted a few days and spread a narrow plume of volcanic ash over parts of Scandinavia and Eastern Europe. The event did not greatly affect the UK but it prompted ICAO and Eurocontrol to establish a task force which produced a European and North Atlantic Contingency Plan for Volcanic Ash.[18]

ICAO has had a key role in establishing international responses to ash incidents. Since 2002, ICAO's International Airways Volcano Watch Operations Group (IAVWOPSG) has been in operation to give guidance on volcanic ash avoidance, monitoring and dispersion.

Guidance that became pivotal to the crisis was contained in the **Convention on International Civil Aviation.**[19] Annex 3 to the Convention, Meteorological Service for International Air Navigation, contains core 'standards and recommended practices'

(SARPS), which are periodically updated.[20] When E15 erupted the guidance used worldwide from ICAO was to avoid *any* amount of ash. The guidance stated:

> Unfortunately, at present there are no agreed values of ash concentration which constitute a hazard to jet aircraft engines... In view of this, the recommended procedure in the case of volcanic ash is exactly the same as with low-level wind shear, regardless of ash concentration – AVOID AVOID AVOID.[21]

There had been moves within the CAA and elsewhere to consider revising the guidance. It was known that more lenient guidance as to what constitutes a hazard should be possible Indeed, the ICAO guidance quoted above explicitly stated that the exposure time of the engines to the ash and the thrust settings at the time of the encounter were known to be relevant factors. However, progress had been slow and ash was not high on the UK agenda (see below). Existing planning and policy accepted ICAO guidance.

## 2. Encountering and responding to the ash crisis

On the morning of 14 April 2010 first reports that a plume of ash had started streaming from an Icelandic volcano began to appear and notifications by the London VAAC of an ash cloud that might affect aviation were circulated in accordance with the Contingency Plan for Volcanic Ash. Given ICAO guidance on ash, once the existing contingency plan had been set in motion, it led inexorably to a standstill in aviation across most of Europe and very soon events became a regulatory crisis for the CAA. In the UK suspensions of airspace began to be put in place the same day from Scotland northwards. During the night of 14 to 15 April, airspace closures spread all over the UK, and from 15 April airspace

across most of Europe was effectively closed.[22] The London VAAC was asked to provide 6 hourly updates on the predicted position of the ash cloud, and closures were revised or confirmed with a six hour time frame throughout the crisis.[23]

'Closing airspace' was essentially a matter of restricting the provision of air traffic control services. ICAO guidance (above) meant that normal air traffic control services could not be provided in airspaces affected by volcanic ash. To accord with the guidance, air navigation service providers across Europe issued notifications to airlines requiring the temporary suspension of air traffic.[24] According to Eurocontrol's timeline the UK stated during a teleconference in the afternoon of 14 April that they were 'preparing for the worst case scenario'.[25] On 15 April NATS began declining to issue clearances for commercial aircraft to fly in UK controlled airspace from midday.[26] The CAA was not involved in the decision, but the ICAO guidance in effect meant the regulators' hands were tied. The CAA immediately supported NATS and issued a NOTAM (Notice to Airmen) reinforcing the decision. As one regulator commented to us '… it would be unusual to ignore ICAO guidance. We are an ICAO contracting state; we have probably contributed to the guidance. We would look rather foolish if we ignored it.'

The eruption of the volcano and notification of the consequent ash cloud was quickly interpreted within the CAA as well as NATS as a potential crisis. It became apparent that a number of factors were coming together to create what one of our interviewees referred to as 'the perfect storm'. The eruption had caused the closure of some of busiest airspace in the world during a peak holiday period; and wind direction and a settled weather pattern meant that the ash cloud was predicted to linger. The CAA initiated the first meeting of the National Airspace Crisis Management Executive (NACME)[27] on 14 April, and

meetings took place three times a day throughout the crisis.[28] A day later the Government Chief Scientist and British Geological Survey started to advise the Civil Contingencies Secretariat. On 16 April the CAA met the Secretary of State for Transport and kept in regular contact with briefings and updates. In the meantime the CAA, NATS and the Met Office were in regular contact with each other and with Eurocontrol.

The ICAO guidance had caused few problems where ash clouds were relatively short lived and where aircraft could divert comparatively easily. Ash remaining over several days in some of the most congested airspace in the world was a different matter. The CAA immediately began working with other interested parties towards a less precautionary response. The task was substantial: to modify internationally agreed guidelines in a matter of days. Central to the CAA's approach was a rapidly established series of teleconferences involving interested parties 'drawing together almost 100 organisations … to assess whether slightly denser contamination than the current ICAO level would be safe'. The first conference was held on 16th April. Eventually on 19 April[29] the CAA achieved agreement on a new safety limit of 2 milligrams per cubic metre of air and European Transport Ministers met and agreed a three band model for classifying ash. Eurocontrol announced that a new zoning system would take effect from 0600 on 20 April. Airspace was reopened that evening, after 5 days of closure. There were some further closures in May (3/5 May in Scotland and Northern Ireland and 8-10 May in other parts of Europe) and on 23 May 2010 the VAAC declared the eruption over.

The period 14-19 April was a period of inaction in the skies over the UK and much of Europe but it witnessed a period of intense activity on the ground which continued into

May and beyond, and we want to look more closely now at how the risk regulation dilemmas caused by the episode were played out by the varying interest groups involved.

*Evolving reactions and challenges*

Initially there was little evidence in the public domain of disquiet surrounding the existing protocols and the regulators' adherence to them. The challenges to ICAO guidance took place largely behind the scenes. The episode was presented in the media primarily as a meteorological event, and earlier ash incidents and the potential for disastrous engine failure were retold. As the crisis unfolded and continued unresolved, new dimensions and concerns surfaced and began to interact. Huge costs were mounting. According to reports appearing in the media, some 95,000 flights were cancelled across Europe between 15 and 20 April[30] and some ten million passengers stranded across Europe,[31] at an estimated cost to the worldwide airline industry of £1.1bn.[32] The costs to airlines through loss of revenue were compounded by the requirements of EU regulations under which EU airlines are required to reimburse the reasonable receipted expenses of disrupted passengers (EU261).[33] In risk regulation terms the production pressures began to grow and the pressure to 'open the skies' began to mount.

Changes in mood and the reactions of different interested parties can be traced in the press coverage of the volcanic ash crisis 15-30 April. There were ten peak days of coverage (16-25 April). Prominent themes quickly became loss of airline revenue; impacts on business; stranded travellers; and the political fallout. As the days passed the emphasis of press accounts shifted. Initially it was on risks to aircraft safety. Days 2-4 also saw some discussion of the health risks on the ground. Reports of travellers affected by the cloud

were prominent during the first ten days but less prominent thereafter. The costs for airlines or the economy featured prominently on 13 out of 16 days, spread across the entire period 15-30 April. Compensation for travellers was a recurring but lesser theme throughout. Criticism of the authorities became increasingly prominent as the episode unfolded. Debates about the necessity of a blanket ban on flying, questioning of the impact of ash on aircraft, and attacks on the authorities for overreacting to the ash cloud and were especially strong 19-22 April (the blanket ban was lifted on 21 April) and 25-26 April. Another study (Chatham House 2012: 27) analysed the media coverage during the event and found that the travel industry dominated the public narrative: 37.5 per cent quotations were from the travel industry compared to 6.9 per cent from scientists and 9.2 per cent air traffic controllers. On the other hand, the CAA did not engage in its own defence even when under direct attack for mishandling the crisis and over-reacting.

Major protagonists in this shifting scenario were the large airlines. BA and Virgin became increasingly vociferous. They were used to flying in areas of the world where volcanoes are more common and BA in particular mounted an increasingly public campaign against the no-fly zone, including holding well publicised test flights in areas affected by the ash (see below). It would be wrong to assume that the airlines were a homogeneous group. Since deregulation in the 1980s and 1990s UK aviation has been an intensely competitive industry. BA is the country's major airline with a fleet of some 233 aircraft, flying some 611 500K kilometres per year.[34] Virgin is the other major full-service airline in the UK but it operates on a much smaller scale than BA flying to just 35 long distance destinations globally compared to BA's over 600 destinations.[35] Neither of these airlines is the largest passenger carrier: this is Easyjet, one of the prominent 'no frills' airlines.[36] Indeed, the market has a number of low cost airlines operating in the UK and Europe with relatively

small fleets.[37] Arguably the most relevant airlines to involve would be the low-cost carriers making large numbers of short haul flights in the affected areas. However, these airlines were not initially fully represented in talks about the volcanic ash. As one interviewee put it, they were not habitually 'at the high table'.

As the production pressures mounted there is little doubt that some of the airlines, especially the large ones, started to use the media to echo their concerns. They were particularly vocal in their criticism of the CAA for closing airspace and taking a long time to reopen it. In a twist on 'blaming the regulator' for failing to control risks, regulation was portrayed as itself the main source of risk. The CAA became the focus of public blame for acting with excessive caution at huge and unnecessary cost, and was accused of being at the centre of a policy fiasco (Budd et al. 2011: 31). In media reporting of the crisis the fact that the regulators were constrained by internationally agreed rules was lost. The complex regulatory position and relationships between the CAA, NATS, Met Office and VAACs were confused, as were the legal powers and responsibilities of different bodies. The CAA did not, however, engage in publicly correcting media portrayals or defending itself. Blaming is a social process serving social goals. In this case public blaming during the crisis was clearly serving the immediate goals of particular interest groups bringing pressure to bear to restart flying, and found a ready forum by providing good stories to consumers of the media. It is likely that the CAA well understood this. An antagonistic response would have helped neither the immediate situation nor longer term relationships. Indeed, one interviewee told to us that the same individuals who were coming across as hostile in the press might also be working hard and co-operatively with the CAA towards resolving the crisis. As the scientific basis for closing airspace was increasingly challenged the Met Office and NATS also became targets of blame (see next section, below).

Behind the scenes it was the engine manufacturers who were crucial to the resolution of the crisis through reframing of the guidance. As explained by the Government Office for Science and the Cabinet Office 'Aircraft and engine manufacturers are responsible for determining what level of ash their products can safely tolerate. Urgent confirmation was needed on whether such a zero tolerance of volcanic ash was necessary to maintain flight safety'.[38] They took several days to agree to the change in protocols. Indeed the European Commission adopted a new three-band model on 16 April before engine manufacturers eventually agreed to them, during the afternoon of 22 April (Chatham House 2012: 43). The effect of the delay was explained by Andrew Haines, Chief Executive of the Civil Aviation Authority, in an interview on 3 May 2010 with the BBC's Radio 4:[39]

> If we've had the assurances from manufacturers that we have now at the start of the crisis, the response would have been different. … The critical path for this decision was the time it took the manufacturers to satisfy themselves on the safe level of contamination. … I suspect that manufacturers knew that there was an acceptable level of safety but what hadn't happened is that they were prepared to underwrite that and validate it.

UK politicians stayed very much behind the scenes during these events. We know from the CAA website that the secretary of state was kept informed but there were few public pronouncements. The Government did not call a meeting of COBR, the crisis response committee, until 19 April and nor were the Department of Transport or Foreign and Commonwealth Office involved till days into the crisis (Chatham House 2012: 45). The regulator was left to defend itself.

*Science and risk*

Crises expose the limits of our ability to anticipate and control risks in modern society. Particular forms of knowledge may be privileged or denied at different moments in the regulatory process, there may be contestation of knowledge and this may align with certain groups marshalling particular sets of scientific data and interpretations and championing them. The E15 volcanic ash example is no exception to this.

In this case science became a vehicle for argument and the evidence base upon which policy and protocols were based became the subject of challenge. Prior to the event the possibility of a volcano erupting and closing European airspace for an extended period was not recognised as serious. ICAO guidance on responding to the presence of ash was unequivocal – but it was not based on detailed scientific knowledge of the impacts of ash on aircraft, nor did it anticipate an eruption that produced an ash cloud in an extremely busy airspace lasting several days. Volcanoes regularly cause some disruption to air travel but this particular volcano had not erupted since 1821 when of course there was no air travel. Because volcanic ash had not been a major problem in Europe it was not prioritised as a high risk demanding major attention. In other words the event was not fully anticipated. Interviewees explained that because volcanic ash in Europe was not regarded as a high risk it had been impossible to get the subject onto aviation agendas, especially at a time when the airlines were working with such tight financial margins.

As the crisis unfolded competing epistemologies began to emerge and three areas attracted particular concern. The first and probably the most crucial were the risks posed by

volcanic ash to aircraft engines. At the start of the crisis there was no consensus about safe concentrations of ash and no publically available data about aircraft engine tolerance of ash. It was suspected that issues of commercial sensitivity may have led to secrecy and also issues of liability regarding advice about 'safe levels' of ash. In this case a particular concern and point of debate was whether ash ejected from a glacier was of a type especially dangerous to aircraft.[40] The complex contractual arrangements between the airlines and engine manufacturers were also tested as some operators maintained that engines were more tolerant of ash than the engine manufacturers were prepared to agree to.

The second set of risks that generated debate concerned measurement and movement of the ash cloud. This information was generated by the London VAAC and formed the basis for continuing closures as predictions were updated every six hours. Airspace was being kept closed on the basis of information as to where it was forecast ash would be rather than actual observation and measurement of ash. Its forecasts were based on various techniques including satellite imaging, laser detection, observations and test aircraft (O'Regan 2011: 24). The absence of obvious evidence of ash (indeed the skies were generally clear and blue) made it more difficult to sustain this approach, as did the fact that different VAACs used different atmospheric pollution dispersion models. The London VAAC used a model called NAME. The underlying science used by the Met Office and London VAAC were soon challenged by the airlines. For example, the Telegraph wrote that 'eleven major British airlines joined forces last night to publicly criticise Nats … over the way it interpreted the Met Office's "very limited empirical data" and that the Met Office had been 'accused of using a scientific model based on "probability" rather than fact'.[41] There was a call for 'hard' data rather than theory and models. Test planes were sent up, initially by the Met Office who conducted a four hour test flight on 15 April, by NERC and by

airlines - British Airways conducted a three hour test flight on 18 April. On 19 April BA's CEO declared that blanket restrictions were unnecessary (HofC timeline), one example of the frustration the airlines were experiencing (see below). Easyjet also conducted test flights. Following these the aircraft engines were scrutinised for evidence of damage. Light Detection and radars (LIDAR) were used in 6 ground locations in the UK to detect ash.

Scientific expertise came to represent a third area of concern. As the crisis unfolded scientists became heavily involved, sometimes aligning with different interest groups in their interpretations of evidence, especially regarding the levels of ash concentration at which damage to aircraft engines was likely. The CAA, Met Office and NERC pooled scientific information from early in the crisis. The Met Office used the UK National Centre for Atmospheric Sciences to independently assess its products. Regulators sought advice about the nature of the ash, the behaviour of volcanoes, the robustness of airframes, aircraft engines and the experience of airlines used to flying through similar ash, for example, the experiences of Air Alaska. But the use of scientists was uneven as demonstrated by the subsequent UK Parliamentary Inquiry which criticised the government for bringing in science too late. The Civil Contingencies Secretariat, for example, did not seek advice from a wide group of scientists until later in the process. Brannigan (2011: 104-5) claims that the central group making airline policy did not include two key parties namely engine engineers and volcanologists.

*Information asymmetries* were highlighted amongst different interest groups (Chatham House 2012: 21). Typically regulators are at a disadvantage compared to large corporations, who can often afford high levels of technical expertise and research and development capacity. In this case, the situation was a little more complex as both the

airlines and the regulators were to some extent dependent upon the engine manufacturers. Beyond this there were significant differences between airlines and their power to define public discourses. At a transnational level there was a lack of harmonization of airspace and European differences were both confusing the situation and exploited by the various interest groups. In the context of all of this it is quite an achievement that the regulators managed to reach anything like a consensus to change protocols and open airspace.

**Discussion**

The premise underlying our analysis is that the processes described above are revealing about regulation in its social and cultural environment. in its social and cultural environment. Although it is necessarily limited in scope, the study confirms this is the case, and provides some clarification of the issues raised at the outset of the paper. The E15 case highlights a number of important sociological issues. In particular it underlines some of the very real dilemmas faced by governments across the world in their attempts to manage risk and demonstrates how risk anticipation, interpretation and sense-making are social processes. The case raises issues at the core of regulatory dilemmas, which in turn are reflective of more fundamental societal tensions. The central justification of regulation is that it controls undesirable risk and it is embedded in socio-cultural and political risk environments which are in the business of managing feelings of vulnerability and demands for security (Haines 2011; Molotch 2012). Regulators are burdened with managing these demands while allowing business to continue. They are invariably blamed when thing go wrong, especially if there is a loss of life, in this case they were blamed for being too precautionary. Had there been a loss of life, a plane crash, we would be writing a very different article and this throws into perspective the underlying dilemmas posed by

regulation and the very real risks surrounding regulation itself. The case raised issues about the extent to which the events of April-May 2010 should have been anticipated; the tensions between safety and finance; questions about who should make the decision about how to resolve these dilemmas; and what the role of science should be. Matters of legitimacy underlie all of these issues, the legitimacy of the decision-makers and the legitimacy of the science. And aligned with these are the varying interest groups who each played a role in shaping the public understandings and narratives of the crisis. In this example, regulatory dilemmas were rooted in competing political, economic, organizational, individual *interests*.

A range of interest groups emerge as dominant/stronger/weaker before, during and after the crisis. In this case the regulators became cast as the fall-guys for following internationally accepted protocols. And various interest groups were material in exploiting the lack of scientific consensus that existed at the start of the crisis. In this case some of the airlines were especially forceful, moreover they appear to have successfully managed the public narrative through the media. Regulation became the focal point of the *blame game,* regulators become scapegoats obfuscating deeper problems regarding the fragility and vulnerabilities of aeromobility (Birtchnell and Büscher 2011: 2). The E15 episode exemplifies the ways in which natural risks can have profound consequences in a world which has become reliant on the air transportation of people, goods and services. It did not lead to any loss of life, but the closure of airspace resulted in massive financial losses, exposed the fragility of transnational air travel and transportation and raised questions about the resilience and vulnerability of critical infrastructures (O'Regan 2011: 21).

The episode also raises further questions about risk-based approaches. One interpretation of the incident is that it may be yet another failure of adhering too rigidly to risk based decision-making. Volcanic ash had not received attention because it was lowly rated risk in Northern Europe, moreover interest groups had refused to discuss/pay attention to because of its low probability. It may be this low probability rating was a result of failing to include the correct experts in the risk assessment or it may be that this was an event that should not have attracted too much pre 2010 attention because the coincidence of events in 2010 were low probability. Some in the industry believe volcanic ash should now demand high attention others question this comparing it to thunderstorms and arguing that they are frequent and their impact equally or more serious than volcanic ash.

Certainly the episode forced reconsideration of the evidence and what counts as evidence, Competing epistemologies emerged as the crisis unfolded and this resulted in a change in the nature of evidence – from theory to hard 'facts', which became the subject of competing interpretations. Through the complex negotiations that occurred 14-20 April, new threshold concentrations agreed, there was a shift from zero tolerance to graded zones of volcanic ash (Lawless 2011b: 237). Other observers regarded this as a more fundamental paradigm shift from one that centred passenger safety to one that privileged protecting the airlines from disruption (Brannigan 2011: 104-5).

An important aspect of risk regulation is the disparities in the regulatory resources of state regulatory agencies, and business and other non-state regulators. These resources might be financial, knowledge based, symbolic resources or reputational resources. Basic financial resources are the bottom line of much regulatory decision-making, resources are not infinite and trade-offs have to be made between risk and profit. State regulators are limited

by their resources which may influence their organization of knowledge, staffing and enforcement approach. They are also mindful, through political context, of the demands they can place on business which in turn will consider resources as one of the factors which determines their compliance levels or, put another way, the extent to which the risks they generate. Financial and especially reputational resources are affected by crises, perhaps in inverse relationship to each other. In this case this may have been partially fuelled by the marketization of the system that arguably exacerbated one of the most basic regulatory dilemmas of all, namely balancing safety and cost. The marketization of other public services has led to new tensions in the relationships between different participants in legal processes and a different use of science. Lawless (2011b), for example, writing about the marketization of forensic services, observed tensions emerging with respect to the role of science with a move from science led to police led use of forensic science.

Some of the regulatory players in this example have been subject to forms of privatization/marketization. For example, NATS is now a commercial enterprise which basically sells its air traffic services in competition with others, there are around 35 air traffic control providers in the UK but NATS is by far the largest. Basically no flights means no income for these controllers. The Met Office is also expected to operate on a commercial basis and the London VAAC is funded effectively by users through the honorary charge – ie out of funds paid by users to the MET office. It is difficult to tell how much this may have played a role in the shaping of this particular crisis but we do know from other examples, notably railway privatization in the UK that such commercial issues can complicate relationships, the exchange of information and even the legitimacy of the organizations involved. It is also possible that further study would find that blaming and responses to becoming targets of blame were affected by these interrelationships.

We do know that in this case regulation came to be framed as itself a source of risk. The end of the crisis was not the end of eruption so much as the solving of the regulatory problem. The CAA came in for enormous criticism during the crisis for following internationally agreed guidance, but they had virtually no room for manoevre. They had little option but to embark on 'ad hoc policy making in a crisis scenario' (Chatham House 2012: 43). Although they were criticized for taking a long time to open the skies, they achieved a crucial change in protocols in just five days of frenetic work and transnational liaison.

**Notes**

[1] Disaster studies are a secondary literature for this work, relevant insofar as it helps us understand and explain the nature and possibilities of regulation. Likewise, risk management literatures are relevant insofar as they have permeated contemporary regulation.

[2] For example, the introduction of forms of meta-regulation (Parker 2002) and meso-regulation (Kaye 2006) whereby the state introduces direct and indirect ways of regulating the regulators.

[3] For example, the explicit principles endorsed by regulatory bodies established to regulate health and safety in the workplace, medicine, financial institutions.

[4] CAA web page www.caa.co.uk.

[5] The Civil Aviation Act 1982; the Airports Act 1986; the Transport Act 2000.

[6] The framework within which it operates is set out in a 'sponsorship statement' published by the Department of Transport At the time of writing the most recent published version was at http://webarchive.nationalarchives.gov.uk/20100513155401/http://www.dft.gov.uk/pgr/aviation/domestic/sponsorshipstatementfortheci2872?page=1, accessed 9 April 2012

[7] The CAA lists several 'associated organisations', including wholly owned subsidiaries, on its website at www.caa.co.uk/default.aspx?catid=2345&pagetype=90&pageid=794.

[8] In his Budget speech of June 2010 the Chancellor, George Osborne, said the Government would seek to sell its 49 per cent stake as part of its programme to reduce the country's huge budget deficit. This is still in progress at the time of writing.

[9] A Trading Fund is a UK executive agency, government department or part of a department, established as a Trading Fund under the Government Trading Funds Act 1973. As a Trading Fund the Met Office has standing authority under the 1973 Act to use its receipts to meet its outgoings.

[10] See www.eurocontrol.int/content/about-us.

[11] www.caa.co.uk/default.aspx?catid=2481&pagetype=90.

[12] www.caa.co.uk/default.aspx?catid=2345.

[13] www.metoffice.gov.uk/about-us.

[14] www.nats.co.uk/about-us/vision-strategy/.

[15] www.nats.co.uk/about-us/vision-strategy/safety-strategy/.

[16] www.eurocontrol.int/articles/eurocontrol-role.

[17] VAACs are responsible for issuing volcanic ash advisories to State flight information centres and Meteorological Watch Offices (MWOs). The MWO then has the responsibility for producing volcanic ash significant meteorological information (SIGMETs) for that state's Flight Information Regions (FIRs) and then it is up to the state's aviation authorities to decide whether the aviation community is further informed through NOTAMs (Notice to Airmen) or ASHTAMs.

[18] ICAO Volcanic Ash Contingency Plan EUR and NAT Regions. The plan is rehearsed through an exercise planning group (Volcex) which has met since the Grimsvotn event under the umbrella of METG, the Met group of the Paris ICAO European Air Navigation Planning Group (EANPG).

[19] Also known as the Chicago Convention, this established ICAO as a specialized agency of the United Nations charged with coordinating and regulating international air travel. The Convention establishes rules of airspace, aircraft registration and safety, and details the rights of the signatories in relation to air travel.

[20] IAVWOPSG advises ICAO what SARPs need to be included in Annex 3 concerning volcanic ash dispersion and international air travel.

[21] Paragraph 3.4.8 of the 2007 ICAO Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds, available at www.paris.icao.int/news/pdf/9691.pdf.

[22] See the CAA timeline www.caa.co.uk/default.aspx?catid=2011&pagetype=90&pageid=12637, accessed 28 September 2012

[23] This confused some passengers as it seemed that re-opening was more likely than it in fact was.

[24] The suspensions were put in place via air traffic flow management restrictions being implemented by the EUROCONTROL Central Flow Management Unit (CFMU).

[25] www.eurocontrol.int/articles/volcanic-ash-cloud-timeline-2010-events.

[26] Technically the CAA did not take a decision to close airspace. The airspace remained legally open, but commercial flights flying under IFR rules were not given clearance by NATS.

[27] NACME includes representatives from the CAA's Safety Regulation Group, the Ministry of Defence, National Air Traffic Services and the Department for Transport.

[28] The information in this section is taken from the CAA timeline www.caa.co.uk/default.aspx?catid=2011&pagetype=90&pageid=12637, accessed 28 September 2012, and the timeline in House of Commons Science and Technology Committee 2011 *Scientific Advice and Evidence in Emergencies,* Third Report of Session 2010–11, p. 11, available at www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/498/498.pdf.

[29] Progress of the teleconferences and the increasing range and number of participants is outlined on their website www.caa.co.uk/default.aspx?catid=2011&pagetype=90&pageid=12637.

[30] BBC News, 21 April 2010.

[31] The Press and Journal, 14 May 2010.

[32] According to the International Air Transport Association, reported in BBC News, 21 April 2010; The Independent, 12 May 2010.

[33] Michael O'Leary, chief executive of the low-cost carrier Ryanair, denounced the rules as absurd and argued that that airline passengers should be entitled to no more than train and ferry passengers. The airline initially said it would only reimburse ticket prices, but it was forced to back down and confirm that it would comply with the regulations. See e.g.

www.independent.co.uk/travel/news-and-advice/recriminations-fly-after-aerial-lockdown-ends-1951261.html.

[34] Details regarding the UK airline industry refer to 2009 and have been compiled from various sources of data available on the CAA website at:

www.caa.co.uk/default.aspx?catid=80&pagetype=88&sglid=1&fld=2009Annual

www.caa.co.uk/default.aspx?catid=80&pagetype=88&sglid=13&fld=2009_2010

[35] Virgin have 38 aircraft compared to BA's 233 and carried 5 363 624 passengers compared to 30 911 199 passengers.

[36] In 2009 Easyjet had 169 aircraft in service, had 306 535 flights and carried 39 062 960 passengers.

[37] These include Flybe, Jet2.com, Monarch, Thomas Cook and Thomson.

[38] House of Commons Science and Technology Committee 2011 *Scientific Advice and Evidence in Emergencies*, Evidence 106, Volcanic Ash - The Work of the DFT Science Group and the CAA, available at www.publications.parliament.uk/pa/cm201011/cmselect/cmsctech/498/498.pdf.

[39] BBC Radio 4, The Report, 3 May 2010, available at www.bbc.co.uk/iplayer/console/b00s6rx6.

[40] This point was hotly debated at the time and became part of the blame game. A recent study suggests that the ash released was 'sharp and abrasive' and did cause a significant risk to aircraft engines. See www.spiegel.de/international/europe/eyjafjallajoekull-study-iceland-ash-did-pose-threat-to-planes-a-758987.html

[41] The Telegraph, 19 April 2010, available at www.telegraph.co.uk/news/7608722/Volcanic-ash-cloud-Met-Office-blamed-for-unnecessary-six-day-closure.html.

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