EYJAFJALLAJOKULL: A GLOBAL HAZARD IMPACTING ON GLOBAL NETWORKS

Iceland's Eyjafjallajokull volcano hit world headlines in April 2010. Countries located at a considerable distance from Iceland, such as the UK, experienced enormous financial losses on account of global airline industries grounding all flights when Eyjafjallajokull erupted. Aeroplane engines are vulnerable to the fine volcanic ash ejected by this volcano into Earth's atmosphere. High altitude winds quickly carried the ash into the airspace of other countries, globalising the hazard. The interaction seen between global-scale physical and human geography makes this a useful case study for students of ***Edexcel GCE Geography AS Unit 1 Global Challenges****. Eyjafjallajokull may also become a popular case study for the* ***A2 Unit 4 option 'Tectonic activity and hazards'****.*

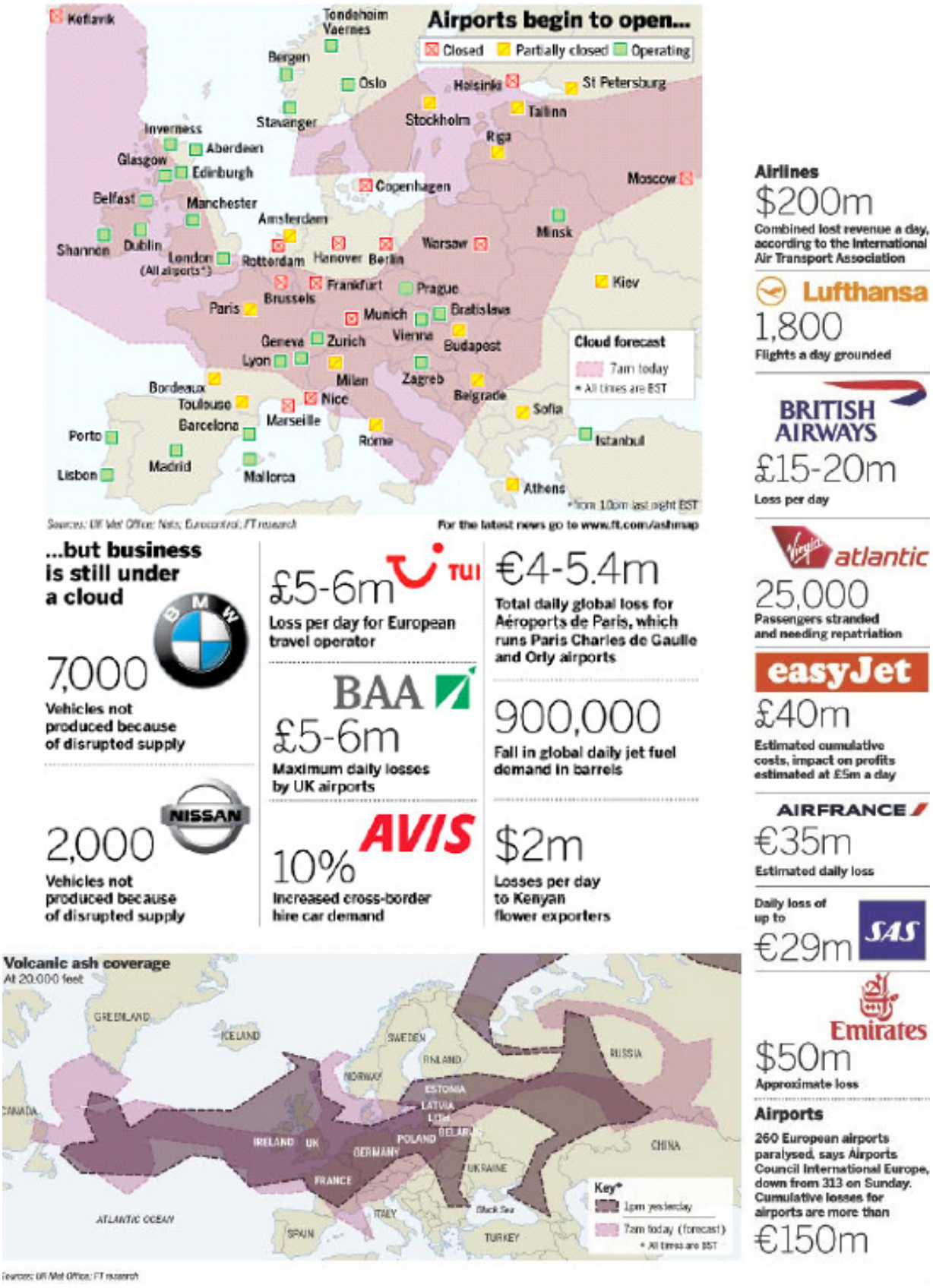
Photograph 1 *The Eyjafjallajokull ash plume*

THE EYJAFJALLAJOKULL HAZARD EVENT

The on-going eruption of the Eyjafjallajokull volcano is a **geophysical** event (Photograph 1). Iceland is located at a **constructive** plate boundary in the Atlantic ocean. Two tectonic plates are diverging due to the movement of convection currents in the Earth's **asthenosphere.** This creates a zone of activity called the Mid-Atlantic Ridge where earthquakes and volcanic eruptions are extremely common. However the **hazard** risk for humans found there is low because the activity mostly takes place under water. One exception to this is the island of Iceland. This volcanic land mass has built up over time due to unusually high levels of volcanic activity (a 'mantle plume' located below Iceland results in especially vigorous up-welling of magma).

Iceland is populated yet most of the 317,000 people living there feel they are at relatively low risk of harm from volcanic hazards. This is because volcanic eruptions along this type of plate boundary are, in general, not highly explosive, unlike those associated with destructive plate boundaries. However, the Eyjafjallajokull volcano has nonetheless proved to be a major geophysical hazard due to the release of a very large ash and gas cloud in April 2010.

The growing cost of the eruption



(Source: Financial Times)

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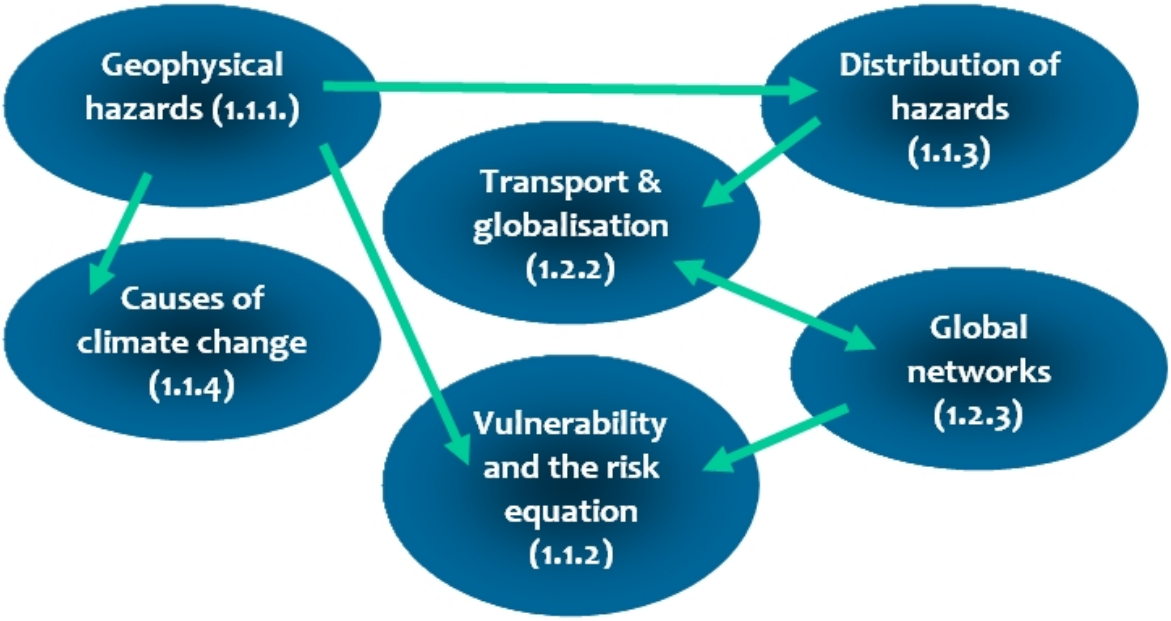
Photograph 2 *The Eyjafjallajokull ash plume*

Enormous quantities of ash and gas have been added to the atmosphere by the Eyjafjallajokull volcano. Such events have, in the past, sometimes brought deadly effects. For instance, the eruption at Laki in Iceland in 1783 emitted an estimated 120 million tonnes of sulphur dioxide gas and extremely fine dust. It left a persistent air haze across western Europe for many months and is estimated to have killed tens of thousands of people through respiratory and other illness (source: *Financial Times*, 16 April 2010).

Luckily, the period of unusual activity that began at Eyjafjallajokull on 14 April 2010 did not release large quantities of poison gas. In the first week it did, however, eject an estimated 110 million cubic metres of material known as **tephra**. The finest tephra materials are tiny particles of ash. Vast amounts of this fine ash rose to a height of about 9 kilometres (30,000 ft) into the air (Photograph 2). By reaching this high level, the ash plume intruded into the flight paths of jet aeroplanes, creating a major hazard risk with all kinds of effects for the global economy (Figure 1).

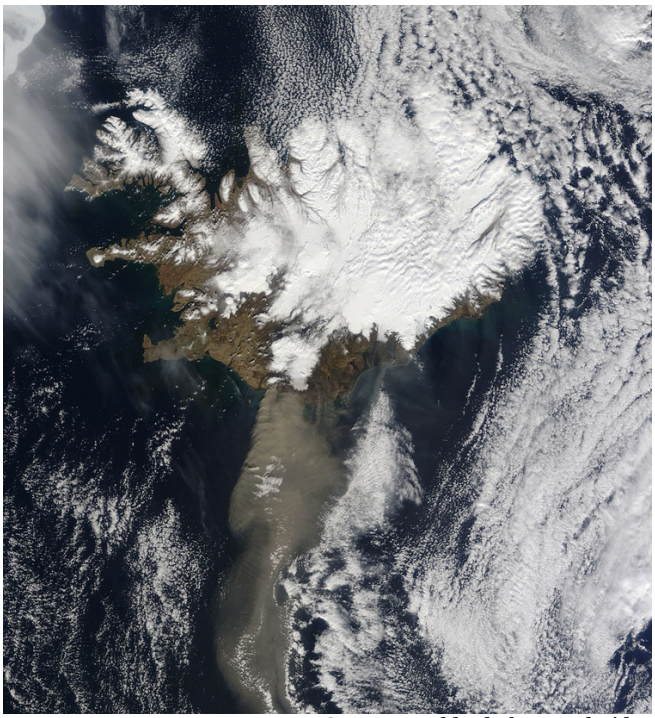
WHAT WAS THE HAZARD PATTERN AND DISTRIBUTION?

The ash cloud, or plume, was spread far and wide by atmospheric processes. Although triggered by a geophysical event (tectonic activity in Iceland), the



This mind map shows the different areas of the Unit 1 Specification that the Eyjafjallajokull case study relates to. The arrows show the way that knowledge and understanding of these different areas of geography can be linked together. These are called **synoptic** linkages. Developing synoptic skills is an important part of A-level studies in geography. Can you explain why each of these different Specification interconnections is shown?

Figure 1 *Mind map showing how the Eyjafjallajokull eruption relates to Unit 1*



© NASA Goddard Photo and Video

Photograph 3 *Aerial photograph of the ash cloud triggered by the Eyjafjallajokull eruption*

hazard event was also partly **hydro-meteorological** in nature. Earth's westerly upper air circulation (of which the fast moving jet stream belt forms a part) meant that large areas of Europe were adversely effected by the dust cloud (Photograph 3). The scale of the event was planetary-wide: the dust travelled thousands of kilometres from its Icelandic source. Moving eastwards, it crossed over the UK and into mainland European airspace (Figure 2).

The Mid-Atlantic Ridge

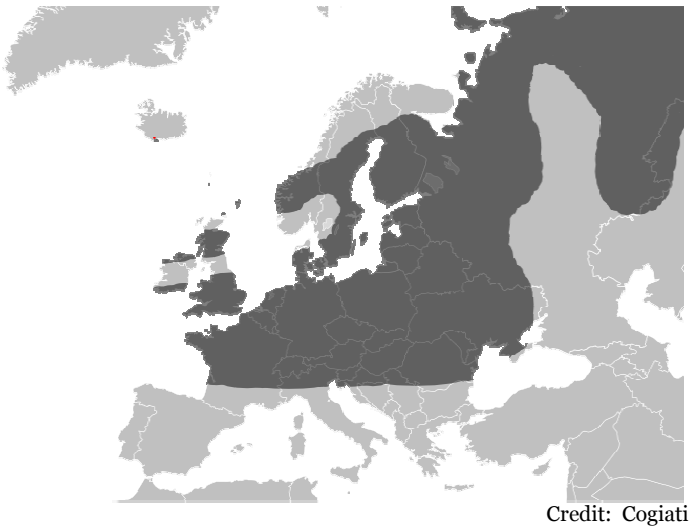
A large-scale elevation rising 1-3 km from the ocean floor. In the middle of the Atlantic ocean, it marks the constructive boundary of adjoining plate margins where up-welling basaltic magma from the mantle arrives at the Earth's surface and adds to the oceanic crust, which spreads laterally away from the line of the ridge (seafloor spreading). The ridge, which is generally more than 1,000 km in width, has been considerably offset by wrench-faults known as transcurrent faults.

Although the majority of the ridges lie beneath 3 km of sea water, several small Atlantic islands, of volcanic origin, rise at intervals (e.g. Tristan da Cunha and the Azores). In Iceland the median rift runs through the centre of this larger island which spans the ridge. Iceland is situated over a mantle plume and its landscape is characterised by a zone of extensive surface vulcanicity such as shield volcanoes and lava plateaux.

The **disaster** potential of this event was much higher than it would have been in the past (Eyjafjallajokull last erupted in 1821). This is because the widespread and routine use of jet aeroplanes has greatly increased global society's **vulnerability**. Fine ash entering the upper atmosphere would not impact on anyone's life other than for the fact that aeroplanes traverse this region. Highly vulnerable to damage if ash enters their engines, aeroplanes must remain grounded when a volcanic plume is detected. (Interestingly, older propeller aircraft are far less vulnerable!) We can also think about these relationships by applying the disaster risk equation (Figure 3).

In Iceland itself, the local air industry did not suffer at first. We can draw a parallel here with the operation of very tall factory chimneys: winds carry pollutants far away from the source region, bringing damage to distant areas but not to the actual polluter itself! However, Iceland was not left entirely unaffected:

- A change in wind direction one week after the eruption began, finally led to ash accumulating over Icelandic airspace, causing Iceland to shut its own international airport at Reykjavík.
- The volcanic eruption also triggered meltwater floods (also known as jökulhlaup) along nearby rivers, requiring 800 Icelandic people to be evacuated.



Credit: Cogiati

Figure 2 *Eyjafjallajökull high-altitude volcanic ash travelling over Europe, 17 April 2010*

COPING WITH THE HAZARD

Authorities in Europe were quick to take action once ash began to accumulate over European airspace. Much of the UK and Europe enforced a 'no-fly zone' as soon as the vast cloud of volcanic ash from Iceland arrived. The risk of a disaster was thought to be too great to ignore (air authorities believed that a plane crash might result - either immediately, or in the future due to long-term engine damage caused by

the ash). 17,000 flights were cancelled during the first 24 hours of the eruption and the complete ban remained in place for many days.

The ban was finally lifted after scientists analysed new data and decided the risks were less severe than had at first been believed (some critics felt European governments were overly cautious waiting quite so long before lifting the ban).

- Some UK citizens sailed their own boats across the English Channel to help pick up stranded tourists – in a manner reminiscent of the famous Dunkirk evacuation during the Second World War.
- The UK government sent navy boats to aid the effort: HMS Albion picked up tourists in Santander, on Spain's north-west coast.
- The insurance industry has an important role helping people and businesses to cope with their financial losses.

RISK = HAZARDS x VULNERABILITY / CAPACITY TO COPE

Figure 3 *The disaster risk equation*

Could the Eyjafjallajokull eruption become a natural cause of global climate cooling?

As Eyjafjallajokull continued to pump ash into the sky, experts considered whether the ash cloud could be expected to have any impact on the planet's climate. However, unlike some massive past volcanic eruptions, such as Krakatoa in 1883, it seems unlikely that the eruption is large enough to significantly reduce world temperature by reflecting incoming solar radiation.

The flight ban *did* stop emissions of an estimated 2.8 million tonnes of CO^2 by aeroplanes. Although the volcano also emitted some CO^2 itself whilst erupting, the net impact on global CO^2 levels will be a slight lowering of the rate of increase because of the mass grounding of flights. (Volcanoes naturally produce millions of tonnes of carbon dioxide every year.)

Examiner's Tip: Students could draw on any of these ideas to support a write-up of the following 5-mark question: ***Explain how volcanic activity can impact on Earth's climate.***

KEY TERMS

Hazard A physical event or process with the potential to harm human life, welfare or assets

Disaster The actual realisation of a hazard that brings harm to human society.

Geophysical hazard A hazard formed by tectonic / geological processes (such as earthquakes, volcanoes, mass movements).

Hydro-meteorological hazard A hazard formed by hydrological processes (floods) and / or atmospheric processes (such as storms, drought and bushfires).

Global flow A movement of money, goods, materials, people or information that helps build interdependency between places and contributes to globalisation.

Global network A network is an illustration or model that shows how different places are linked together. Geographers use the term global network to emphasise the many long-distance connections that exist between different places.

Constructive boundary A tectonic plate boundary where two plates are diverging, creating new crust as magma rises towards the Earth's surface, spreads and cools.

Asthenosphere A semi-molten zone of rock underlying the Earth's solid crust; hotspots within the asthenosphere drive the convection currents that cause plate movement.

GLOBAL NETWORKS

The economic impacts of the eruption were enormous. The costs to businesses and tourism added up to more than £2 billion, as a number of different global networks suffered interrupted flows for a total of 6 days following April 14.

- Tourist flows were halted. People cancelled immediately up-coming holidays, while 150,000 British tourists became stranded overseas and could not easily return when their home flights were cancelled.
- Temporary movements of professional workers were brought to a halt. For instance, several UK bands could not fly to the famous US desert music festival in Coachella to perform. The Cribs with Johnny Marr, Frightened Rabbit and Bad Lieutenant were all grounded by the ash.

- Some medical operations were cancelled after the movement of refrigerated human organs from overseas donors could not take place.
- A near shutdown of the agricultural export sector in Kenya occurred. Refrigerated storehouses filled up and some exporters were forced to throw away produce destined for UK markets. On a normal day, 1,000 tons of perishable produce (worth £2 million) is flown to the UK. Flowers and vegetables valued at many millions of pounds were wasted and around 5,000 workers were temporarily laid off.
- Car production lines worldwide ground to a halt as the flight ban starved manufacturing of key electronic components. The 'just-in-time' lean model of production means many modern industries do not keep large stocks of parts on their premises any more; and so are highly vulnerable to any interruption to the flow of parts.

All of these problems highlighted our modern globalised world's dependence on complex, worldwide supply chains that are reliant on air transport. However, one type of global flow actually increased as a result of the Eyjafjallajokull hazard event: the global flow of internet information received a boost! Video-conferencing firms saw business boom as many firms organised virtual meetings for staff after international conferences were cancelled when delegates could not catch flights. US company Cisco Systems experienced a surge in demand for their company's video-conferencing services.

KEY POINTS

- Ash clouds add to the hazard potential and disaster risk associated with tectonic activity.
- Diffuse ash clouds greatly increase the area affected by a tectonic hazard, increasing the numbers of people whose welfare and incomes are affected.
- Modern technology means society's vulnerability to the effects of high-level ash clouds has actually increased over time due to the heavy costs of grounded air flights.
- Air flights are essential for the operation of different types of global network, moving flows of tourists and perishable goods from place to place.
- Physical factors such as ash clouds can interfere with the functioning of global transport and trade networks.

EXAM QUESTION PRACTISE ZONE

Describe the areas affected by the eruption. (3 marks)
(Tip: Make sure you capture the main trend and any unusual 'anomalies'. Try to use data - such as distances - in your answer. Do not start explaining the movement.)

Referring to the risk equation, suggest why the economic costs of the Eyjafjallajokull eruption are higher than last time an eruption of this type took place. (5 marks)
(Tip: Focus on how modern technology has made society vulnerable in new ways. Be clear about what the economic costs were.)

Explain why some places experience greater geophysical hazards than other places. (15 marks)
(Tip: You should be able to access a high level mark by focusing on hazards located at plate boundaries and showing that these are, in general, not found far away from plate margins. However, the way in which ash from Eyjafjallajokull spread westwards is an excellent theme to also adopt as you can emphasis the resulting pattern of affected places.)

Explain why different kinds of global flows can increase or decrease over time. (15 marks)
(Tip: The Eyjafjallajokull eruption provides a physical factor to discuss here - alongside human factors such as technology advancement, government policies, actions of TNCs etc.)

REFERENCES AND FURTHER RESEARCH

The BBC provided good overall analysis of the events at: http://news.bbc.co.uk/1/hi/uk/8625813.stm

The *Financial Times* is very good for its account of economic impacts (including airline share price falls) at http://www.ft.com/cms/s/0/eba8c76e-4983-11df-9060-00144feab49a.html

View an interactive ash cloud map at http://www.esa.int/esaEO/SEMKDU9MT7G_index_0.html

The Sun newspaper evacutes people: http://www.thesun.co.uk/sol/homepage/news/2944545/Stranded-couple-will-get-home-to-see-their-son-get-married-today.html