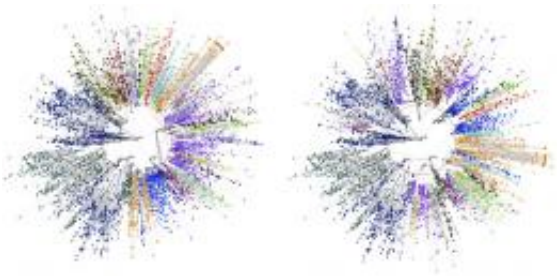
Eyjafjallajokull's Global Fallout

April 23 2010



Shortest-path tree of Atlanta, USA. An impact of the airport closures before and after closures.

(PhysOrg.com) -- Eyjafjallajokull and its massive cloud of volcanic ash clearly have had an enormous impact on Europe and its airports, disrupting the mobility of millions and costing airlines more than a billion euros. But what about the volcano's effect globally?

While much more difficult to determine, Northwestern University professor Dirk Brockmann and his research group jumped at the chance to examine the global impact. Mobility patterns in places far from Europe -- including the United States, India and southeast Asia -- were significantly affected by the European disruption, to the surprise of Brockmann.

The team compared the entire worldwide air transportation network before and after the 27 major European airports were closed and used complex network theory to compute and list the most affected airports

still operating.

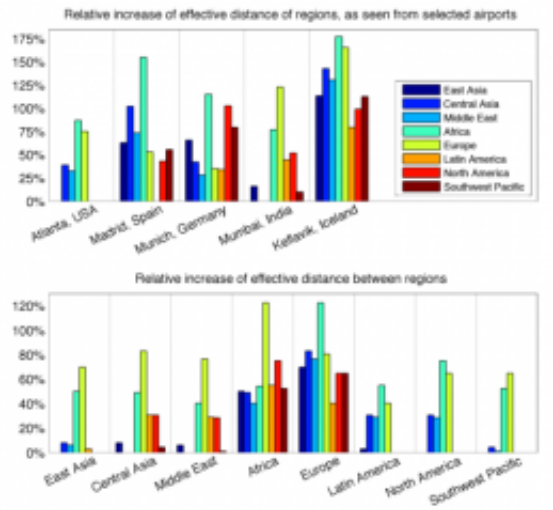
"We were surprised to discover that at the top of the list were airports outside of Europe, not airports in Europe," Brockmann said. "Singapore, Hong Kong and Beijing are some of the high-traffic airports most affected, despite being geographically distant from Europe and separated from Iceland by continents."

He and his graduate students Daniel Grady, Christian Thiemann and Olivia Woolley also found that airports like Madrid and Dubai have become more central in the entire air transportation network, taking over the role of the closed airports.

Brockmann and his group have expertise in running simulations and computational models of human transportation networks and pandemic diseases. He is associate professor of engineering sciences and applied mathematics at Northwestern's McCormick School of Engineering and Applied Science.

"European airports are bridges to the world -- the majority of global air traffic goes through Europe," Brockmann said. "The distances to places have increased globally as a result of the volcanic ash disruption. Mumbai, for example, has become more disconnected than we expected from the U.S. and Africa. Flights from the U.S. to Mumbai normally go through Europe, but now Mumbai is a more distant city to us."

A trip that may have required two flights before the volcano's eruption might have taken four or five trips when the situation was at its worst, which translates into more time, says Brockmann.



Relative increase of effective distances in the network

At the peak of the disruption, with the 27 major European airports closed, 10 percent of the entire global air traffic system was removed. The slowdown in air traffic affected not only the mobility of people but that of fresh vegetables and fruit, grains and other food, medicine, machinery parts and more.

"The removal of those 27 nodes dramatically affects the entire complex system," said Brockmann. "We can quantify Eyjafjallajökull's effect and illustrate it, which is not a simple thing to do." (After much practice, he can pronounce the volcano's name. It is pronounced EYE-a-fyat-la-jo-kutl.)

"In this case, the entire air transportation system was slowed but still works," said Brockmann, who most recently studied the spread of swine flu. "Our calculations show that an actual system breakdown requires the removal of 80 percent of the airports from the system. This shows how robust the system is."

The researchers next plan to make a comparative analysis of the Eyjafjallajökull's event and the effects of 9/11 on air traffic and mobility.

Provided by Northwestern University