Case Study

Ground-breaking application predicts the spread of infectious diseases in a globalized world

esri Canada

St. Michael's Hospital proves link between air travel and the spread of infectious diseases

With more than two billion passengers flowing through the global airline transportation network every year, infectious disease threats that once were localized can now rapidly transform into global epidemics, compromising global health, security and prosperity. A scientific research team based out of St. Michael's Hospital has developed a platform that enables rapid analysis of human movement through commercial air travel and its correlation to the international spread of infectious diseases.

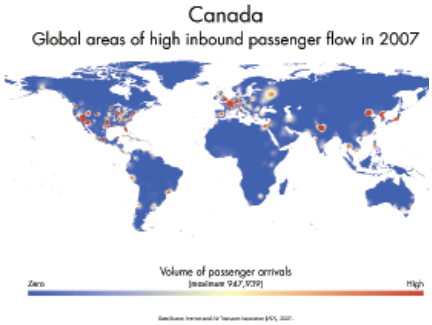
Challenge

In 2003, the worldwide outbreak of SARS revealed an urgent need to improve pandemic preparedness and response strategies on a global scale. Many countries were ill equipped to manage the outbreak which led to thousands of infections, hundreds of deaths and billions of dollars in economic losses around the world. The H1N1 'swine flu epidemic also evolved into a worldwide pandemic with global health and economic consequences greatly exceeding that during SARS.

Although epidemics like SARS and H1N1 are inevitable, there is a limited amount of research into the role of commercial air travel as a conduit for the spread of infectious diseases. This is highlighted by the fact that national and international pandemic influenza plans do not currently account for global patterns of commercial air traffic and their implications on preparedness and response strategies. Research into global population mobility is also limited by a lack of quality data on the global airline transportation network and worldwide commercial air traffic patterns.

To address this knowledge gap, a multidisciplinary scientific team based out of St. Michael's Hospital in Toronto, Ontario developed BIO.DIASPORA – a scientific platform that enables methodological and applied research into the relationship between commercial air travel and the global spread of emerging infectious disease threats.

Human population density is integrated with international flight pathways out of the city to show how Toronto is connected with the world's population through flight pathways.



Heat map revealing areas of the world where the highest volumes of airline passengers travel to Canada.

"With Esri's broad capabilities, we were able to quickly produce maps and put them on the Web. We will continue to move towards Web mapping as a powerful vehicle to communicate our findings across the globe."

Dr. Kamran Khan, MD, MPH, FRCPC
Centre for Research on Inner City Health
Division of Infectious Diseases
St. Michael's Hospital

Solution

To create the BIO.DIASPORA architecture, three key software components were fused together. SAS business analytics software was implemented to integrate and manage data, MATLAB technical computing software was used for data analysis and numeric computation and ESRI's ArcGIS technology provided a powerful visualization component that brought the data to life through a range of compelling Web maps.

A wide range of data sources were then secured and integrated including worldwide passenger ticket sales for over two billion passengers, global flight schedules, real-time flight status data and global airport data.

The team leveraged ESRI's robust functionality to create heat maps, contour maps and simulations that could answer key questions such as: Where are the vulnerable points of entry in this province? What is the probability of the spread of infectious disease based on a defined set of criteria? How many international passengers arrived in a particular city?

The application facilitates an understanding of how humans travel via commercial airlines as a way to predict how infectious diseases are most likely to spread around the world. Next, the team will leverage ESRI's modeling and analytic capabilities to look at the role of temperature, humidity, rainfall and human/animal interaction in the spread of infectious diseases.

Benefits

BIO.DIASPORA was used to accurately predict the spread of the H1N1 virus through an analysis of international passenger departures out of Mexico, and subsequently, proved a correlation between air travel and the spread of infectious disease during the pandemic.

The application has since been used to analyze Canada's vulnerability to emerging infectious disease threats and based on findings, offers valuable suggestions to help strengthen Canada's emergency preparedness and response capabilities. It also tracked population movement related to the 2010 Vancouver Winter Olympics and compared these results to findings from the past five Olympic Games with an aim to identify significant trends and patterns.

This same conceptual model was then applied to monitor infectious disease threats in South Africa for the FIFA World Cup. The team created a map that showed the high concentration of passengers travelling from 15 different cities, the time it would take passengers to travel into South Africa, and the infectious disease threats that were present in those cities. For example, the map revealed that hand, foot and mouth disease was present in Singapore; measles were present in Harare, Zimbabwe; mumps were present in London, England; and tuberculosis was present in Dakar, Senegal.

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