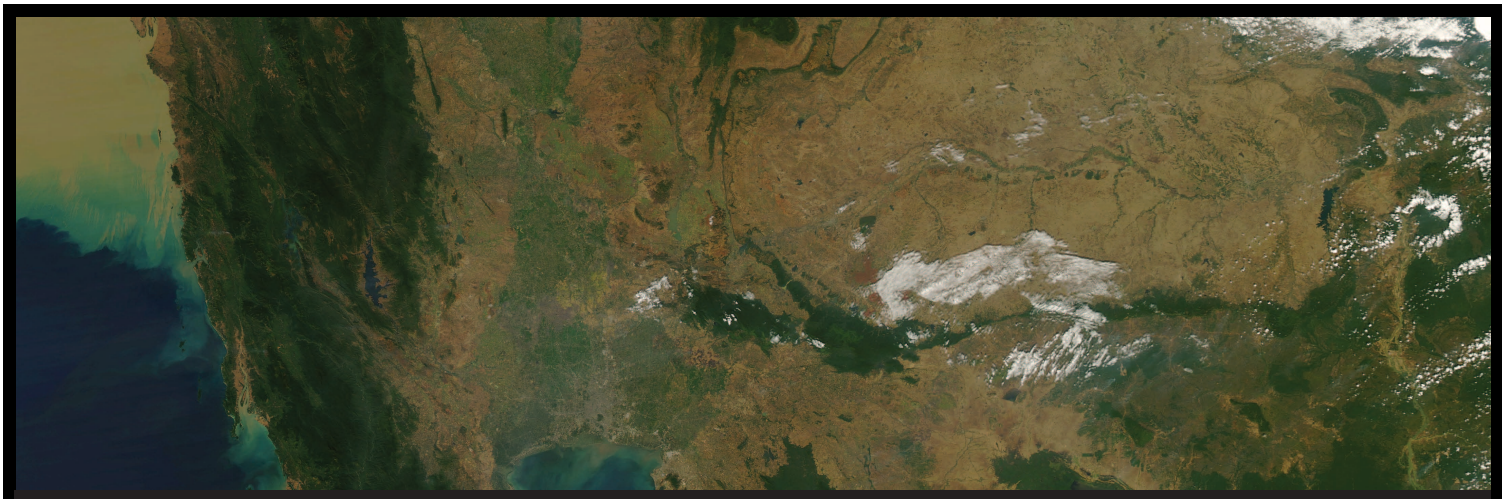
National Aeronautics and Space Administration

Avian Influenza Early Warning:

Using NASA Data to Predict Pandemics



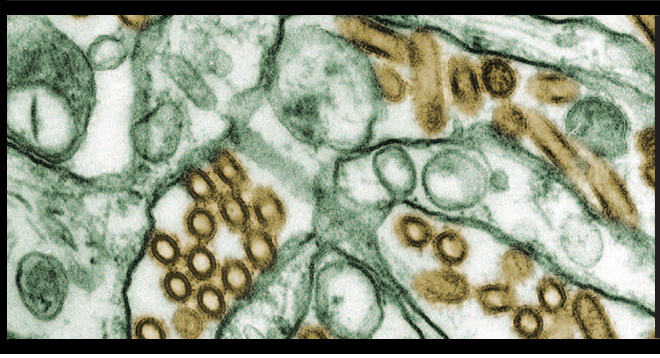
In the mid-1990s, avian influenza (bird flu) emerged in southern China. Severe outbreaks in the winter of 2005-2006 spread the virus—designated H5N1—across Asia, Europe, and Africa, killing hundreds of people, thousands of wild birds, and millions of poultry. Data from the Moderate Resolution Imaging Spectroradiometer (MODIS) aboard NASA's Terra and Aqua satellites are helping researchers to better understand the global ecology of avian influenza—in particular its association with agricultural land use and wild waterfowl migration.

Outcomes of the Project:

- **Avian influenza outbreaks projected based on outbreak history, environmental parameters, and socioeconomic factors**
- **Avian influenza outbreaks predicted based on wetland distributions, prevalence of bird species, flyways of migratory birds, surface characteristics, and socioeconomic factors**
- **Projected spread of avian influenza virus among poultry farms under typical environmental and socioeconomic conditions**
- **Predicted weekly influenza-like illness cases for selected regions in the US and the tropics**

Photo credit: Youthkee

Most cases of avian influenza infection in humans have resulted from contact with infected poultry like domesticated chickens, ducks, and turkeys. Domestic ducks often inhabit rice paddies in China and Southeast Asia where they come in contact with free-ranging ducks. Free-ranging ducks can serve as hosts for the H5N1 virus—potentially spreading bird flu.



Colorized transmission electron micrograph of avian influenza A H5N1 viruses (shown in gold) grown in Madin-Darby Canine Kidney Cells (shown in green). Image courtesy of the Centers for Disease Control (CDC).

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Summary

NASA data, models, and analysis techniques are used to enhance the decision capabilities concerning avian influenza (AI) and pandemic influenza risks. AI is an infection caused by avian influenza viruses. The co-infection of AI and human influenza in humans may produce virus strains to which humans have little resistance and lead to a pandemic among humans.

AI is of particular concern to public health officials in Asia. The virus first appeared in Hong Kong in 1996-1997; this highly pathogenic avian influenza then spread to approximately 60 countries and more than 250 million poultry were lost. 35% of the human cases are in Indonesia; worldwide, the mortality rate stands at 53%, but is 81% in Indonesia. Even more alarming is that 80% of all fatal cases in Indonesia occurred in only three adjacent provinces.

There are three methods by which avian influenza is transmitted: poultry trades, pet bird trades, and migratory birds. Evidence indicates that migratory birds have a significant role in introducing AI into Europe, but a less significant role for Africa and Southeast Asia. The transmission pathway through migratory birds is complex. The Low Pathogenic Avian Influenza (LPAI) viruses are common among wild birds. Such infection is low pathogenic and usually not fatal, but will delay the migration for migratory birds. Once the LPAI viruses are transmitted to domestic birds and poultry, however, the viruses mutate efficiently and change into Highly Pathogenic Avian Influenza (HPAI) viruses in several weeks. The HPAI is deadly for domestic birds and poultry. After the HPAI viruses are transmitted back to the wild and migratory birds, they may carry the HPAI viruses to other regions while they are still able to fly. Along with poultry trades, these spill over, spill back processes are the main mechanisms by which the HPAI virus is spread around the world.

Domestic AI viruses can spread among poultry farm distribution centers, wet markets, and poultry industry service providers. The on-farm and off-farm spreads and within and across sector spreads may become the most significant transmission pathway if the poultry industry is not closely regulated. Humans may be infected after contact with HPAI infected birds or poultry, although human-to-human transmission of HPAI may only occur with prolonged, close contact with infected individuals.

The USDA Animal and Plant Health Inspection Service (APHIS), and the US DoD Global Emerging Infection Surveillance and Response System (GEIS) have partnered with NASA to enhance the capabilities for assessing AI risks for poultry farms and humans, and the capabilities for early detection of pandemic influenza. In particular, NASA, along with its partners, will generate the spatio-temporal risks of AI outbreaks for selected regions in Indonesia, plus short-term and mid-term influenza-like illness forecasts for selected regions in Indonesia, the United States, and other parts of the world.

Project Details

Fourteen NASA Earth sciences data products and models are used in the project. These data and models include: radiance from ASTER and EO-1 ALI, precipitation from TRMM, surface temperature, NDVI and water vapor from MODIS on Terra and Aqua, DEM from SRTM, backscatter coefficients from the Canadian RADARSAT, NASA certified commercial high-resolution data products, GMAO Seasonal Forecast Model output, Textual-Contextual Classifier, Neural Network Risk Prediction Model, and other risk assessment models.

Controlling AI outbreaks brings substantially more benefits to society than to just the farms where the outbreaks occur. It spares extensive culling, preserves the livelihood of small farmers, and protects food security and biodiversity. When humans are co-infected with both AI and human flu viruses, pandemic causing viruses may emerge as a result of genetic reassortment. Better prediction of human influenza will help detect a pandemic when it starts to form. Therefore, the outcomes of this project may reduce the possibility of the emergence of pandemic causing viruses and provide early warning when a pandemic becomes inevitable.

For more information about this project

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NASA APPLIED SCIENCES PROGRAM & PUBLIC HEALTH

This program focuses on the use of NASA assets to support planning and decision making for the public health, medical, and environmental health sectors. The application includes epidemiologic surveillance of infectious disease, environmental health, and emergency response and preparedness. Public Health also explores issues of toxic and pathogenic exposure, natural and man-made hazards for risk characterization and mitigation, and improvements to health and safety.