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Bird Flu — It's What's for Dinner: What Human Population Growth and Climate Change Mean for the Future of Avian Influenza Outbreaks

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Bird Flu — It's What's for Dinner

What Human Population Growth and Climate Change Mean for the Future of Avian Influenza

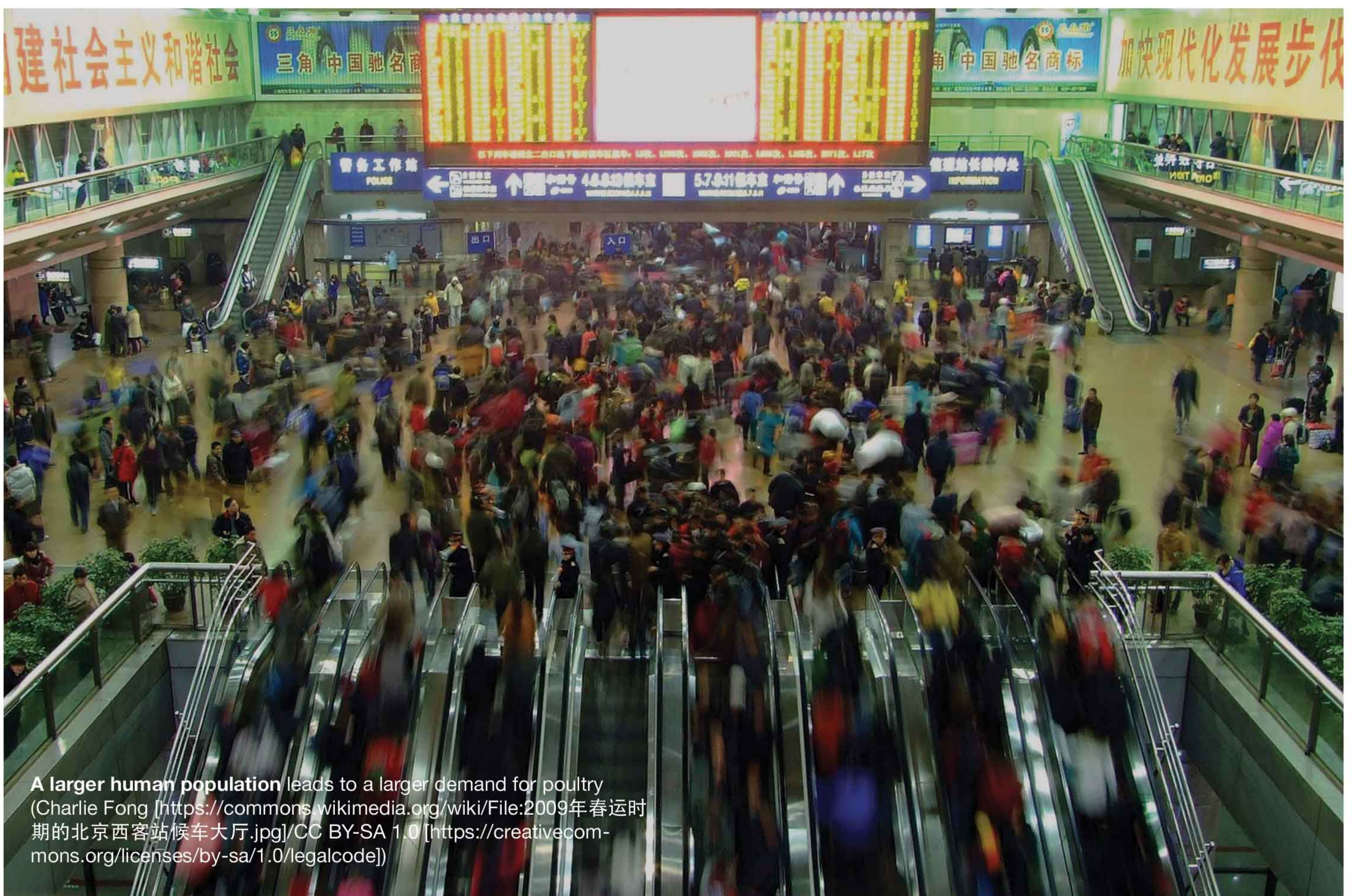
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China is currently experiencing its fifth epidemic of “bird flu,” or avian influenza H7N9, since 2013 when it was first noted to cause human infections. The virus, which is mainly transmitted from poultry to humans, is also prone to limited human-to-human transmission. To date, there have been 1,258 human cases, with one-third of those cases (460) occurring during this year's epidemic alone.¹ There are many “subtypes” of avian influenza circulating in birds around the world and most of these viruses cause limited or no human infections. However, two avian influenza subtypes causing high human mortality have jumped from birds to humans in the last decade,

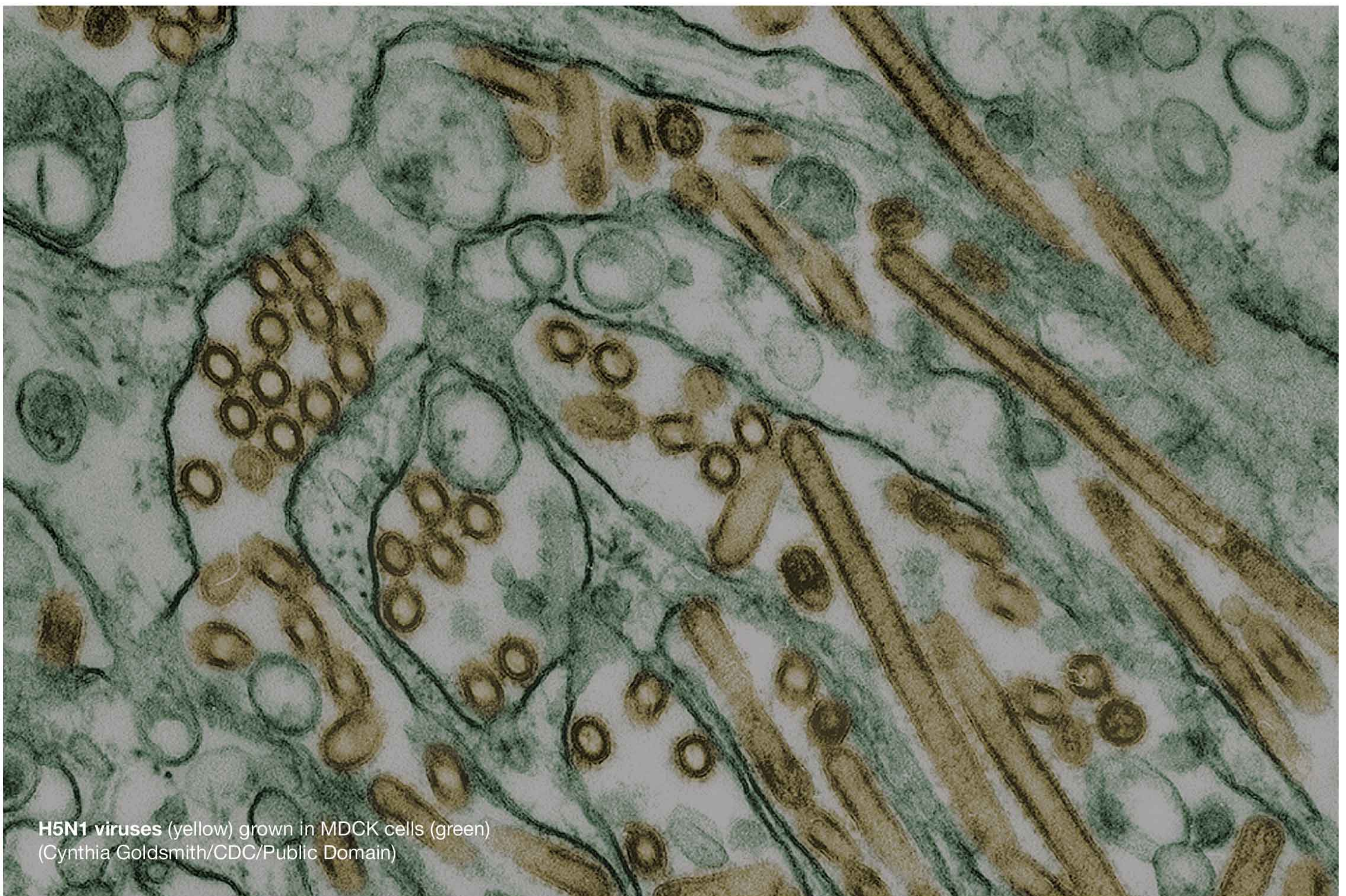
H5N1 and then H7N9. The significant potential of this class of viruses to cause a human pandemic is a global public health concern, particularly because the conditions leading to the rise of these infections are becoming more favorable — for the viruses.

Influenza viruses are notorious at mutating quickly and hence can take advantage of similarity between hosts as well as the increased frequency of interactions between species

The story of how new avian influenza viruses end up infecting humans is similar to other instances of “spillover,” an event that allows the viruses to adapt over time to infecting species other than their natural reservoirs. Wild aquatic birds are the natural reservoirs of avian influenza, and human infections can occur when the virus is exchanged between wild fowl and domestic poultry (or



A larger human population leads to a larger demand for poultry (Charlie Fong [https://commons.wikimedia.org/wiki/File:2009年春运时期的北京西客站候车大厅.jpg]/CC BY-SA 1.0 [https://creativecommons.org/licenses/by-sa/1.0/legalcode])



H5N1 viruses (yellow) grown in MDCK cells (green)
(Cynthia Goldsmith/CDC/Public Domain)

other animal species), and then mutates enough to be transmitted from poultry to humans.² Spillovers are likely happening all the time but they do not necessarily “take” every single time. Influenza viruses are notorious at mutating quickly and hence can take advantage of similarity between hosts as well as the increased frequency of interactions between species. Closer habitation of wild and domestic birds such as poultry, and then of humans and poultry, allows a slow percolating phenomenon where influenza viruses adapt over multiple interactions between the species to become better at infecting humans.

Unfortunately, the largest driving force in making these jumps possible is human population growth. The world population has pushed past 7.3 billion and the United Nations predicts, despite a declining population growth rate, that by 2050 the human population will be 9.7 billion.³ As we grow, we affect changes in land use, extending farmlands and decreasing areas of wetlands which serve as natural reserves for wild water fowl due to increased demands for fresh drinking water.⁴ The U.S. has seen a loss of 50 percent of its wetlands over

the last couple of centuries.⁵ Together with climate change,⁶ these changes have altered the distribution, composition, and movement of wild bird species, and in some cases have forced closer cohabitation of domestic and wild birds, allowing myriads of chances for the first step of the spillover process to occur.

A larger human population also has caused the demand for protein sources to surge. We are raising more birds, along with pigs and cows, for meals. Since 1961, global meat production has quadrupled,⁷ responding not just to population growth but also increasing wages and urbanization. The UN Food and Agriculture Organization reported that poultry meat makes up most of the addition meat consumption worldwide, because poultry is cheaper to produce and more affordable to buy than other meats.⁸ Industrialized nations consume the most protein per capita but the new demand is actually arising from China, as well as low- and middle-income countries, where population growth rate is higher. By 2024, poultry will make up almost half of the source of meat worldwide, all translating into a greater number of cohorted birds in industrialized farms or on domestic

pastures interacting with other animals and wild fowl. Bird flu already wreaks significant losses on the poultry industry worldwide, both because of the direct deaths of sick birds but also the massive killing of healthy birds undertaken as control measure.^{9,10}

Not only are the human and poultry numbers increasing, the growth of cities is creating crowded living conditions that could serve as tinder if a highly infectious strain of avian influenza were to adapt to spreading between humans. Half of the world's population now lives in cities and towns.¹¹ "Wet" poultry markets, or store fronts that sell live birds, in urban centers have been implicated in the transmission of prior and current avian influenza outbreaks in humans and their temporary closure has been a key intervention in halting the spread of new human infections.¹² These markets bring humans, poultry and other domestic animals near each other, allowing a steady learning environment for influenza viruses to adapt to infecting new species.

The mosaic of forces behind the emergence of avian influenza perfectly encompass the concept of *Planetary Health*, the idea that climate change, human health, and animal health work in tandem, and imbalance in any part of system can lead to devastating effects everywhere.¹³ Research attempts at predicting the rise of new avian influenza viruses in humans consider not just infectious diseases biology but also climate change science, animal conservation, human behavioral and agricultural practices, and satellite information.¹⁴ These multi-disciplinary approaches will be important not just

in the scientific world but also in the public health sector, as we wade further into an era where humans become a bigger and bigger threat to their own existence.

¹ Helen Branswell, "Human Cases of Bird Flu are Surging, Alarming Public Health Officials," *STAT*, February 28, 2017, <<https://www.statnews.com/2017/02/28/bird-flu-surge/>> (accessed April 11, 2017).

² Kirsty R. Short, Mathilde Richard, Josanne H. Verhagen, Debby van Riel, Eefje J.A. Schrauwen, Judith M.A. van den Brand, Benjamin Mänz, Rogier Bodewes, and Sander Herfst, "One Health, Multiple Challenges: The Inter-species Transmission of Influenza A Virus," *One Health* 1 (2015): 1–13.

³ "World Population Projected to Reach 9.7 billion by 2050," *United Nations Department of Economic and Social Affairs*, July 29, 2015, <<http://www.un.org/en/development/desa/news/population/2015-report.html>> (accessed April 11, 2017).

⁴ Kurt J. Vandegrift, Susanne H. Sokolow, Peter Daszak, and A. Marm Kilpatrick, "Ecology of Avian Influenza Viruses in a Changing World," *Annals of the New York Academy of Sciences* 1195 (1) (2010): 113–128.

⁵ *Wetlands Protection*, U.S. Environmental Protection Agency 843-F-01-002a, September 2011.

⁶ M. Gilbert, J. Slingenbergh, and X. Xiao, "Climate Change and Avian Influenza," *Revue Scientifique et Technique (International Office of Epizootics)* 27 (2) (2008): 459–466.

⁷ Michael Renner, "Peak Meat Production Strains Land and Water Resources," *Vital Signs*, August 22, 2014, <<http://vitalsigns.worldwatch.org/vs-trend/peak-meat-production-strains-land-and-water-resources>> (accessed April 11, 2017).

⁸ OECD/FAO, *OECD-FAO Agricultural Outlook 2016–2025*, 2016 (Paris: OECD Publishing, 2016), 1–12.

⁹ Peggy Lowe and Sarah Boden, "Avian Flu Outbreak Takes Poultry Producers into Uncharted Territory," broadcast on "Morning Edition," National Public Radio, May 21, 2015.

¹⁰ Lisa Schnirring, "Vietnam Reports H5N6 and H5N1 Outbreaks as Europe Battles More H5N8," *Center for Infectious Disease Research and Policy*, February 20, 2017, <<http://www.cidrap.umn.edu/news-perspective/2017/02/vietnam-reports-h5n6-and-h5n1-outbreaks-europe-battles-more-h5n8>> (accessed April 11, 2017).

¹¹ United Nations Population Fund, "Urbanization," October 3, 2016, <<http://www.unfpa.org/urbanization>> (accessed April 11, 2017).

¹² Xiaoyan Zhou, Yin Li, Youming Wang, John Edwards, Fusheng Guo, Archie C.A. Clements, Baoxu Huang, Ricardo J. Soares Magalhaes, "The Role of Live Poultry Movement and Live Bird Market Biosecurity in the Epidemiology of Influenza A (H7N9): A Cross-Sectional Observational Study in Four Eastern China Provinces," *Journal of Infection* 71 (4) (October 2015): 470–479.

¹³ Sonila Cook and Oren Ahoobim, "The Planet's Health Is Essential to Prevent Infectious Disease," *The Guardian*, May 15, 2016, <<https://www.theguardian.com/global-development-professionals-network/2016/may/15/the-planets-health-is-essential-to-prevent-infectious-disease>> (accessed April 11, 2017).

¹⁴ UC Davis Veterinary Medicine, "PREDICT Activities: What We Do," <<http://www.vetmed.ucdavis.edu/ohi/predict/predict-activities/index.cfm>> (accessed April 11, 2017).

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