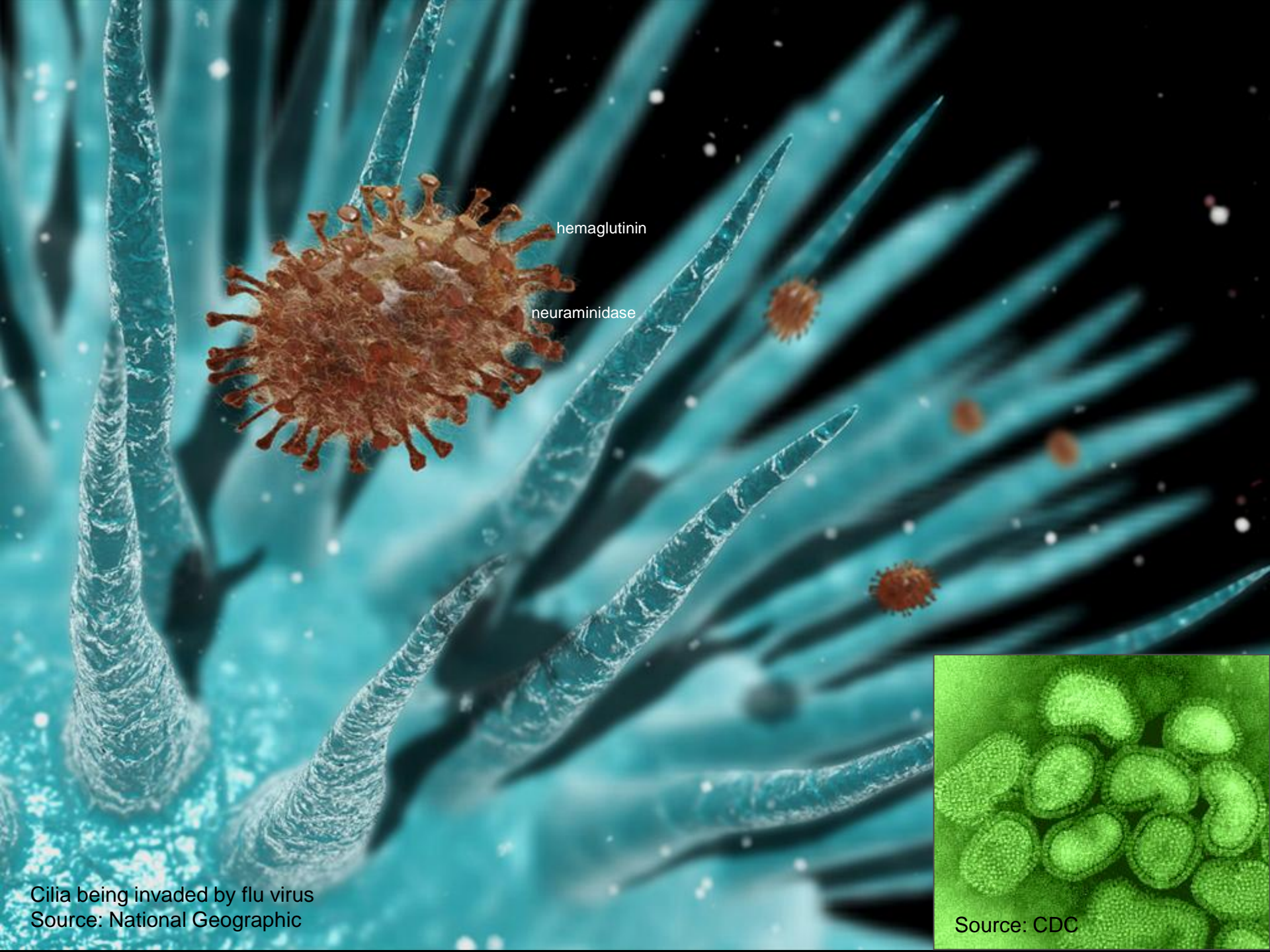


Avian Influenza Risk Prediction And Pandemic Influenza Early Warning

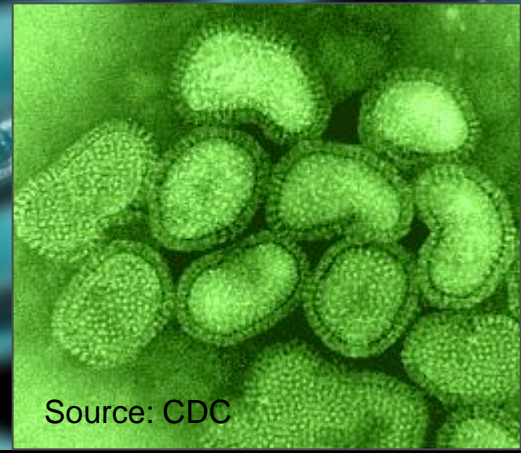
**Richard Kiang, Radina Soebiyanto, Farida Adimi
NASA Goddard Space Flight Center**



hemagglutinin

neuraminidase

Cilia being invaded by flu virus
Source: National Geographic



Source: CDC

THE PROBLEM



- First appeared in Hong Kong in 1996-1997, HPAI has spread to approximately 60 countries. More than 250 million poultry were lost.

- 35% of the human cases are in Indonesia. Worldwide the mortality rate is 53%, but 81% in Indonesia. In Indonesia, 80% of all fatal cases occurred in 3 adjacent provinces.



- Co-infection of human and avian influenza in humans may produce deadly strains of viruses through genetic reassortment.

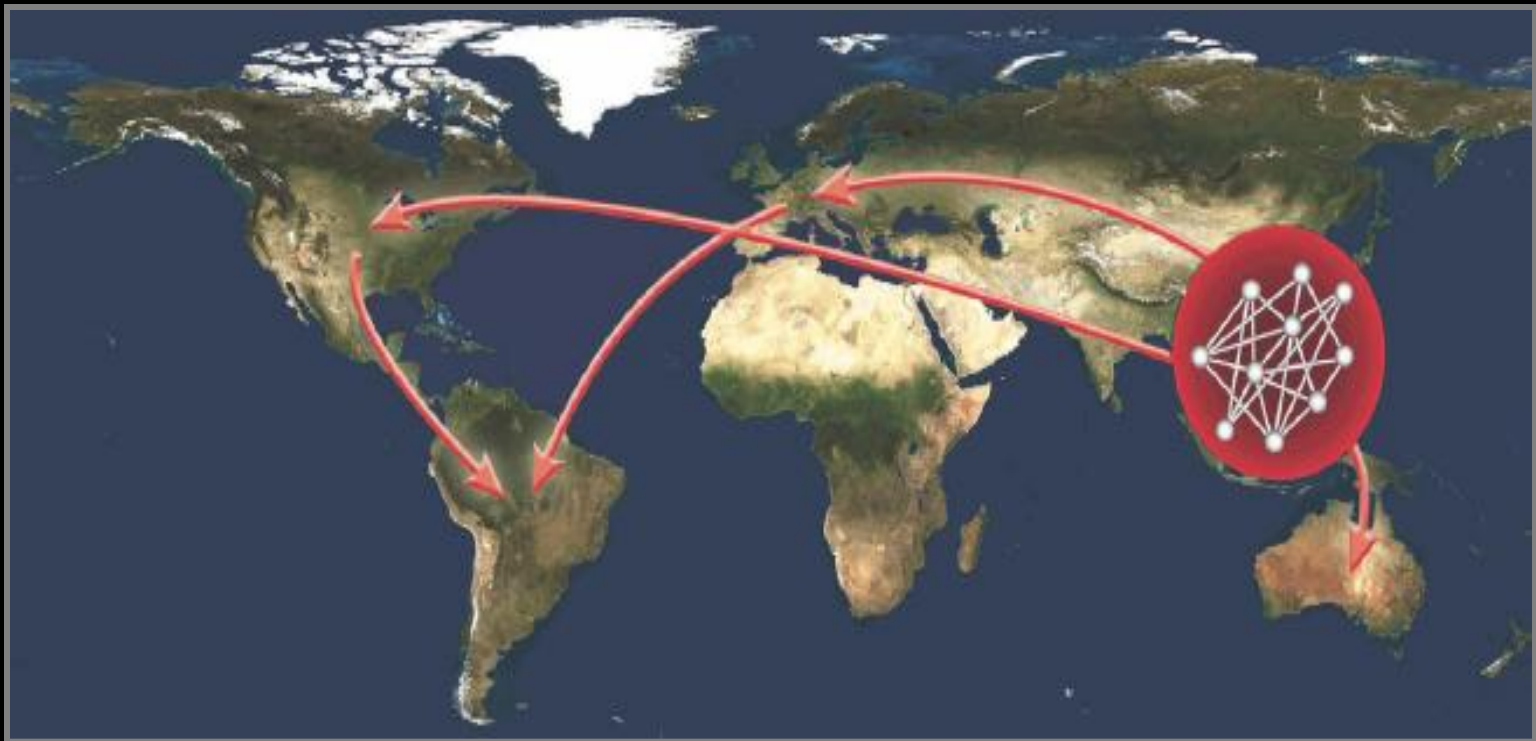
- On average one major pandemic occurred in each century. 90 years have passed since the 1918 pandemic (0.675M deaths in the US, and 21-50M deaths worldwide).

- HPAI H5N1 was found in Delaware in 2004.



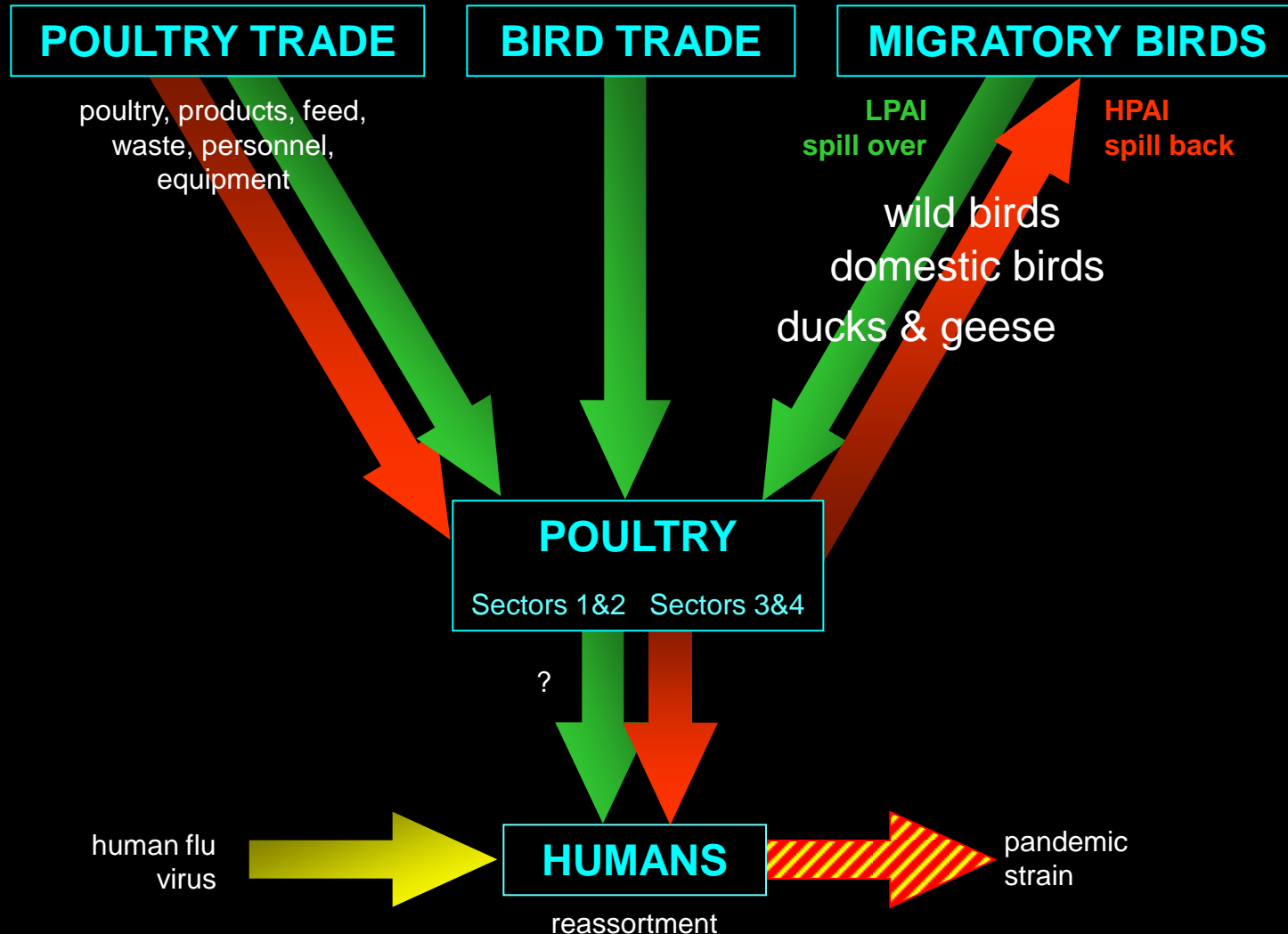
New Flu Strains Often Appear in SE Asia First Before Migrate to Other Regions

Migration Route of Seasonal Influenza A(H3N2) Virus



Source: Russell et al., Vaccine 265 (2008)

TRANSMISSION PATHWAYS



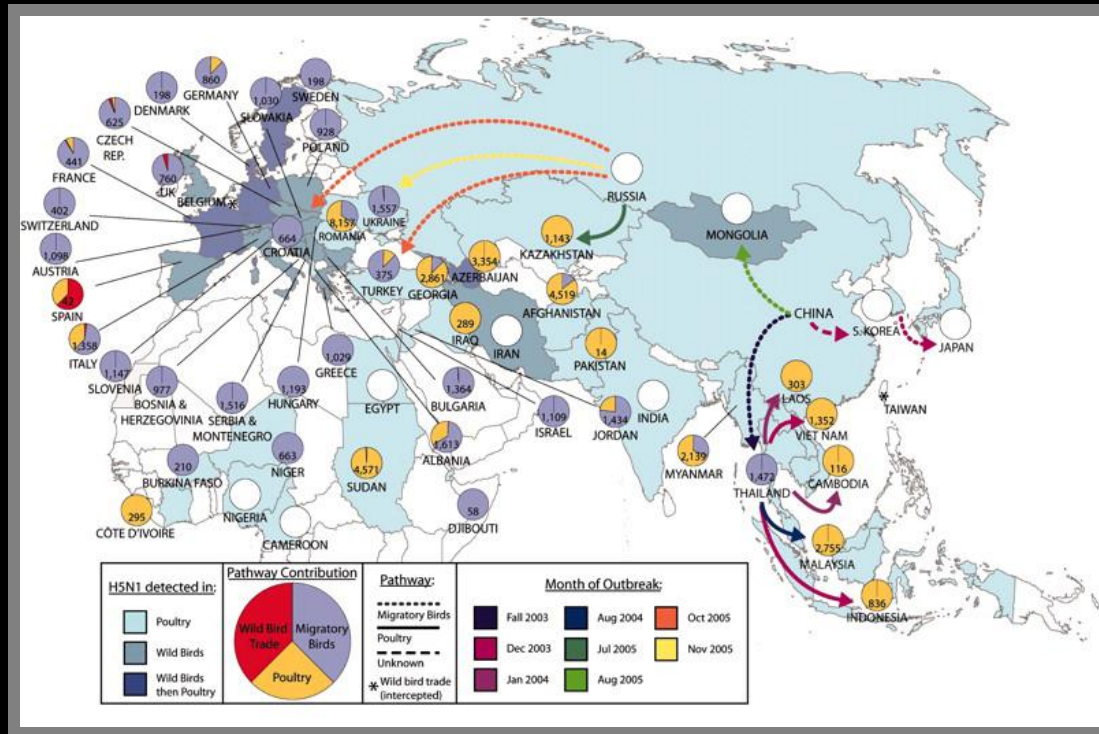
Analysis of Global Spread of H5N1 through Phylogenetic Evidence, Poultry & Bird Trades, And Bird Migration Data

Europe

87% thru mig. birds

Africa

25% thru poultry
38% thru mig. birds



US

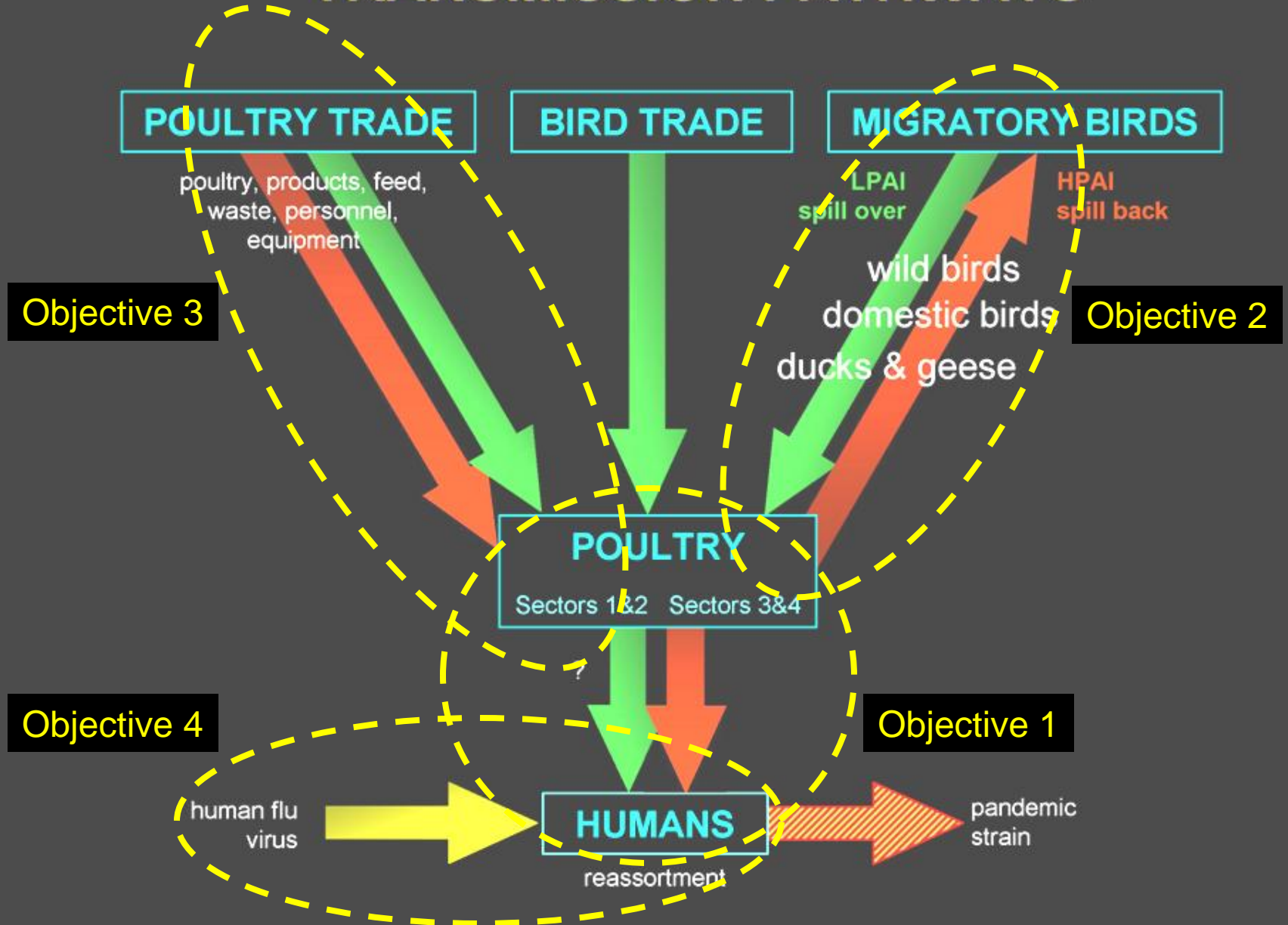
Most likely thru poultry to surrounding countries first, then thru migratory birds to US mainland

Asia

43% thru poultry
14% thru mig. birds

Source: Kilpatrick et al., PNAS 2006.

TRANSMISSION PATHWAYS



OBJECTIVES

- Perform empirical AI outbreak risk analyses based on outbreak history, environmental parameters, and socio-economic factors.
- Identify spatiotemporal risk for AI outbreaks based on wetland distributions, prevalence of bird species, flyways of migratory birds, surface characteristics, and socioeconomic factors.
- Model the spread of AI virus from large commercial poultry farms to small and backyard farms under typical environmental and socioeconomic conditions.
- Model weekly influenza-like illness cases based on observed and forecast meteorological parameters for regions in the US and some tropical countries.

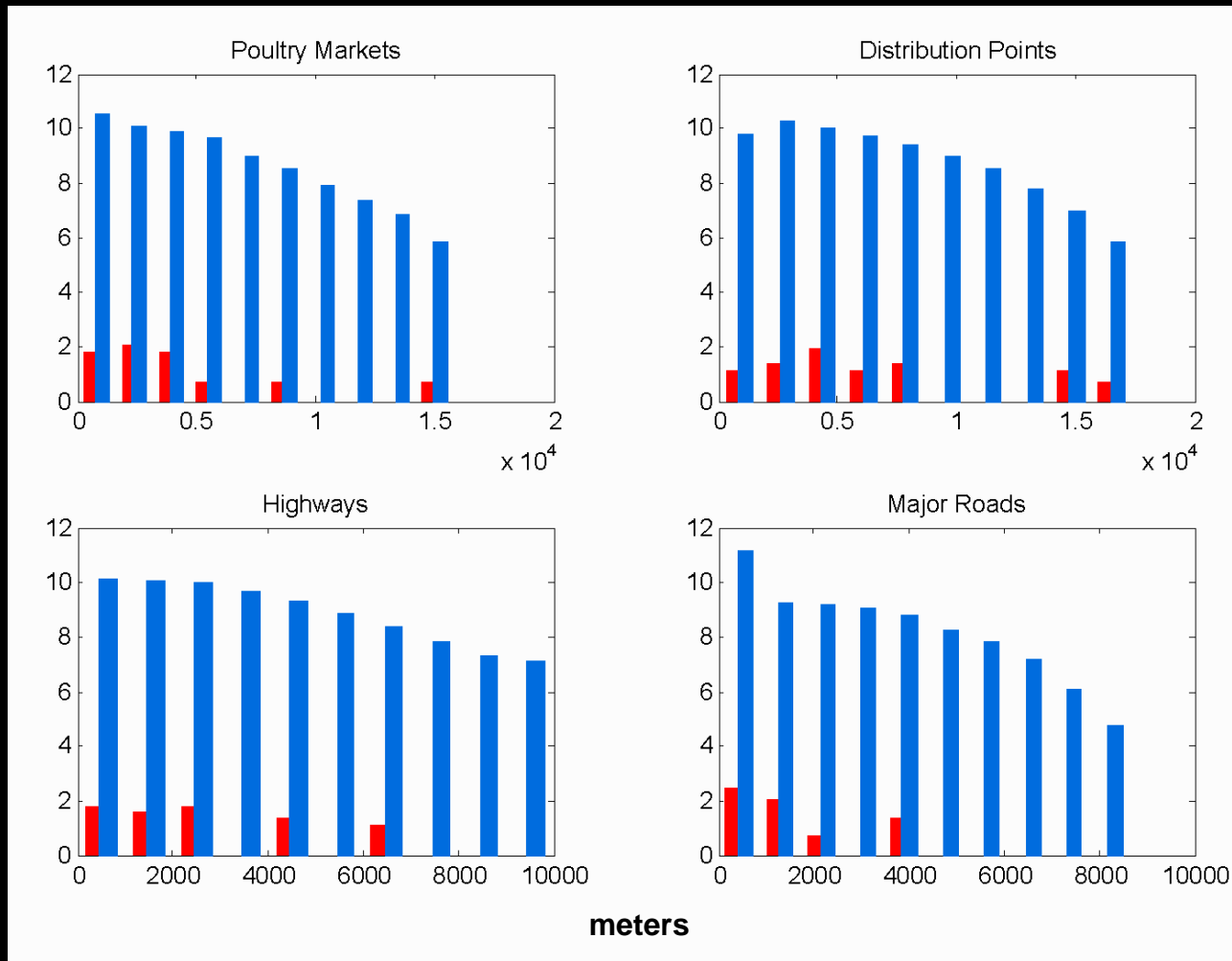
Objective 1

Empirical Risk Analysis

What environmental and socio-economical factors may contribute to HPAI outbreaks?

Histograms of Distance from Neighborhoods With/without Outbreaks to Other Locations

Log (N+1)

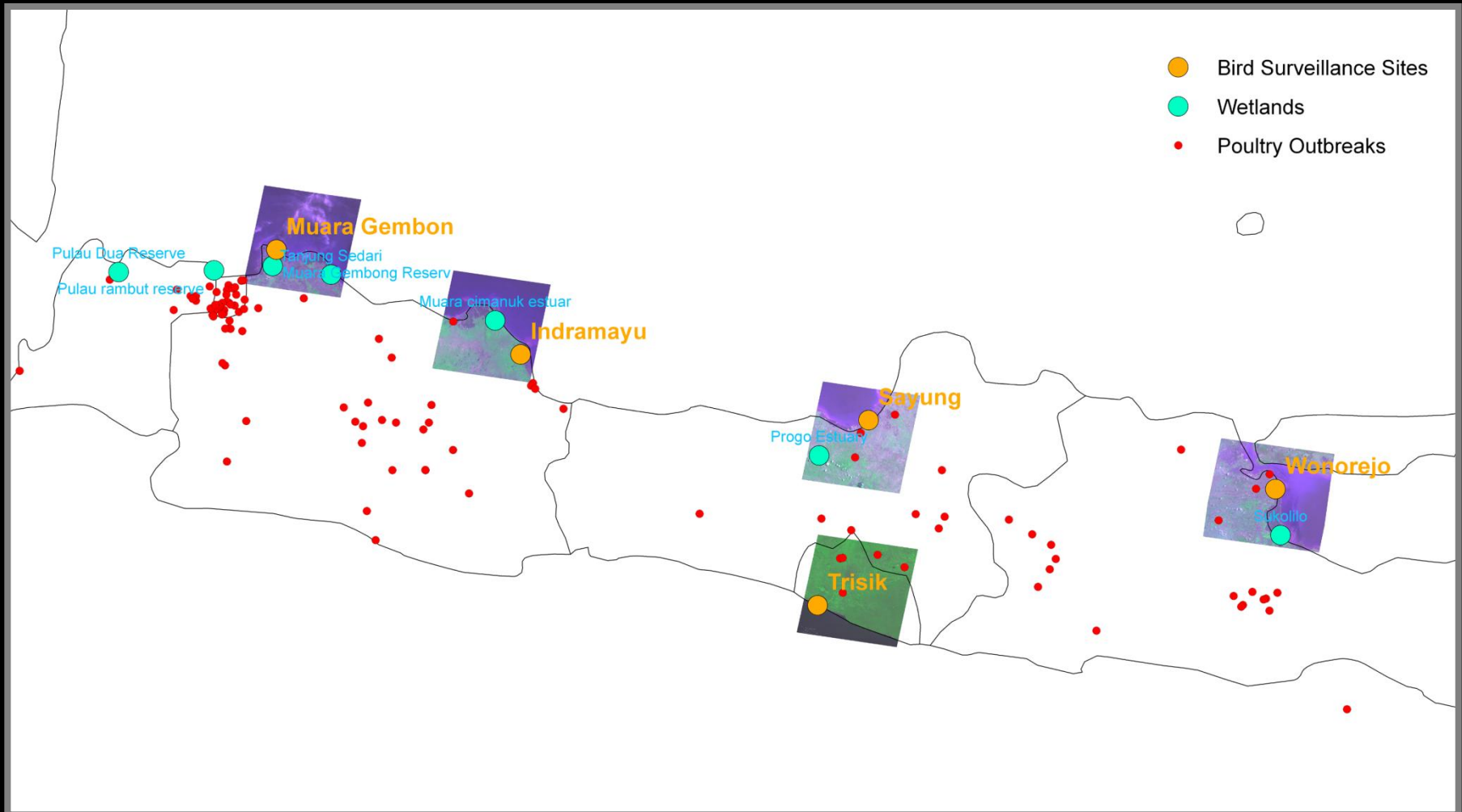


Objective 3

Risks Around Wetlands

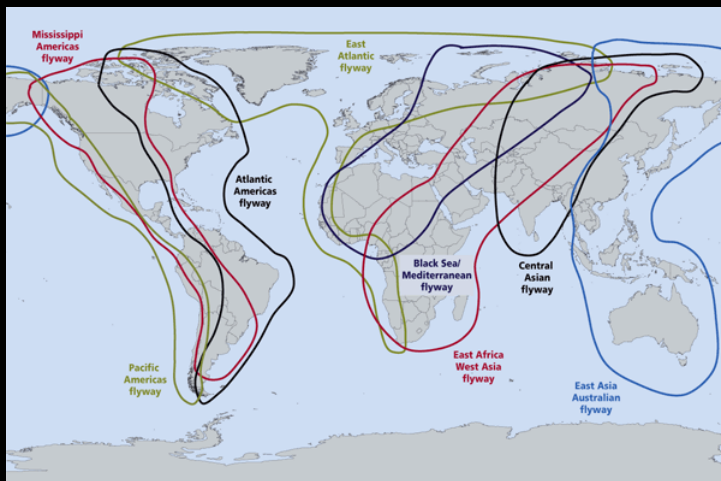
What areas around wetlands may have higher risks for AI outbreaks?

NAMRU-2 Bird Surveillance Sites on Java



NAMRU-2 Bird Surveillance Study

- The role of migratory birds in the spread of H5N1 remains under considerable debates.
- In Indonesia, migratory pathways are only known for shorebirds (East Asian-Australasian flyway) and migratory ducks and geese (East Asian & Central Asian flyways).
- 4067 birds comprising of 98 species and 23 genera were collected in 2006-2007.
- Most common birds: striated heron, common sandpiper, and domestic chicken.



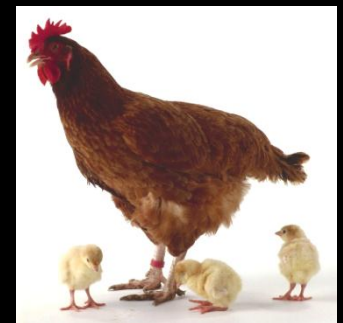
3%



6%



14%

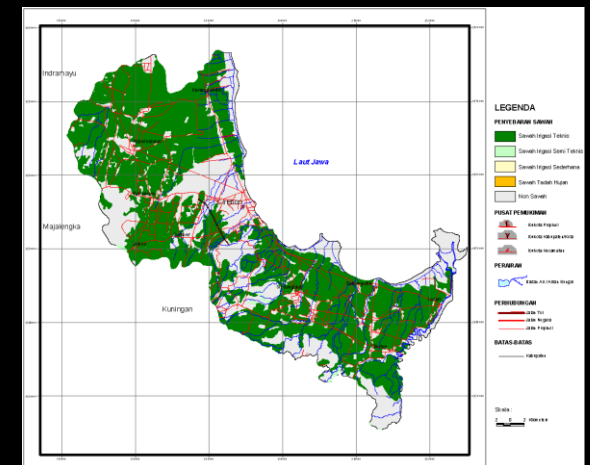
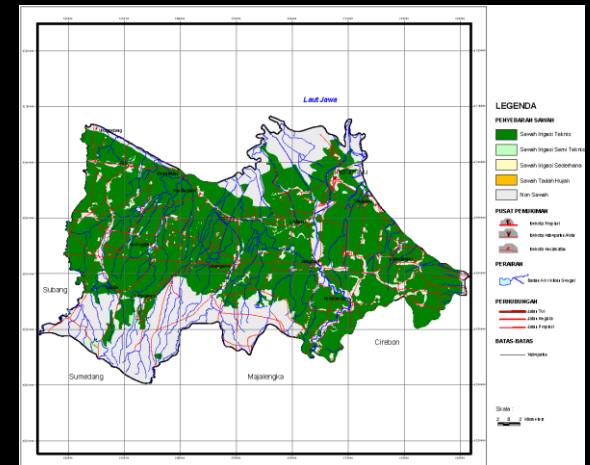
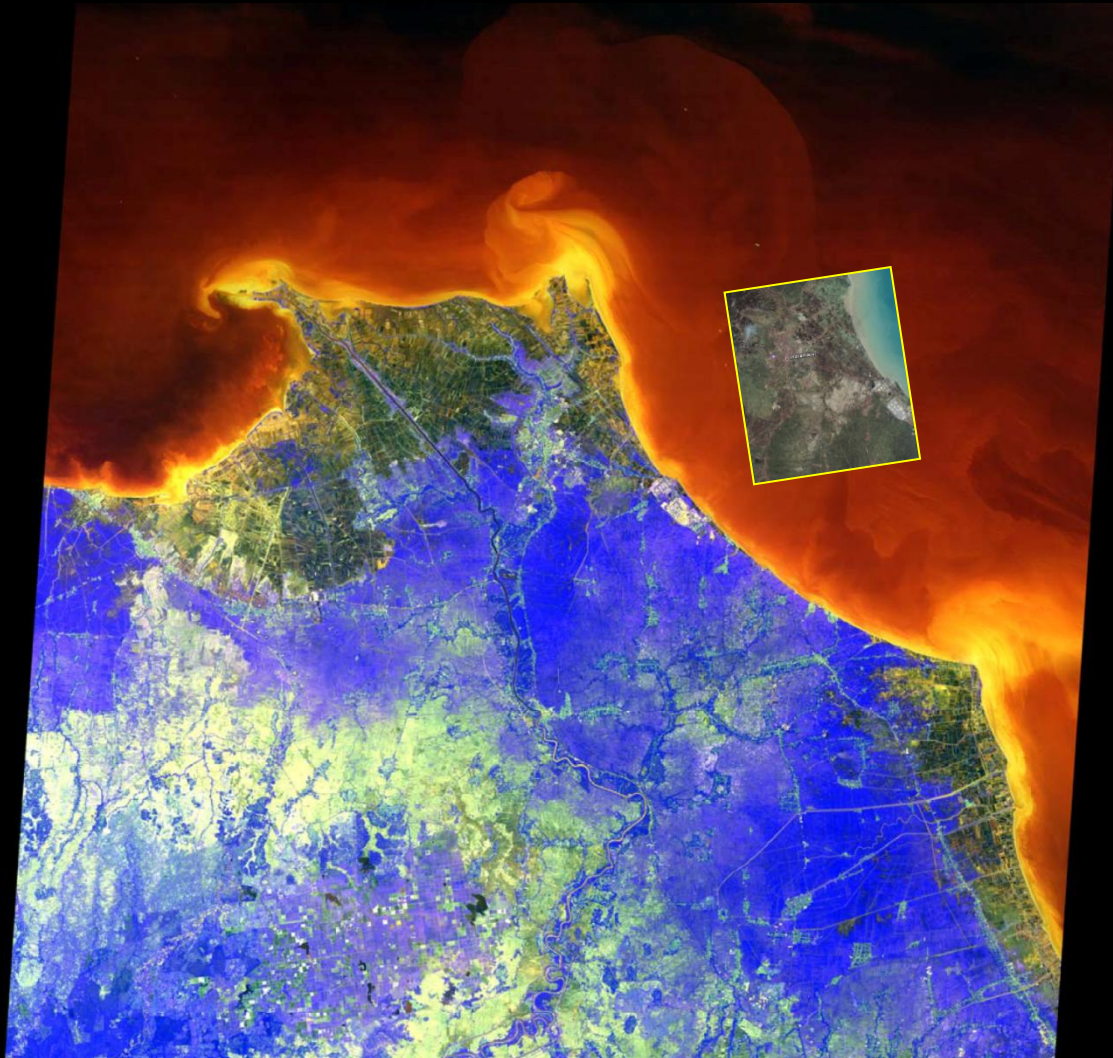


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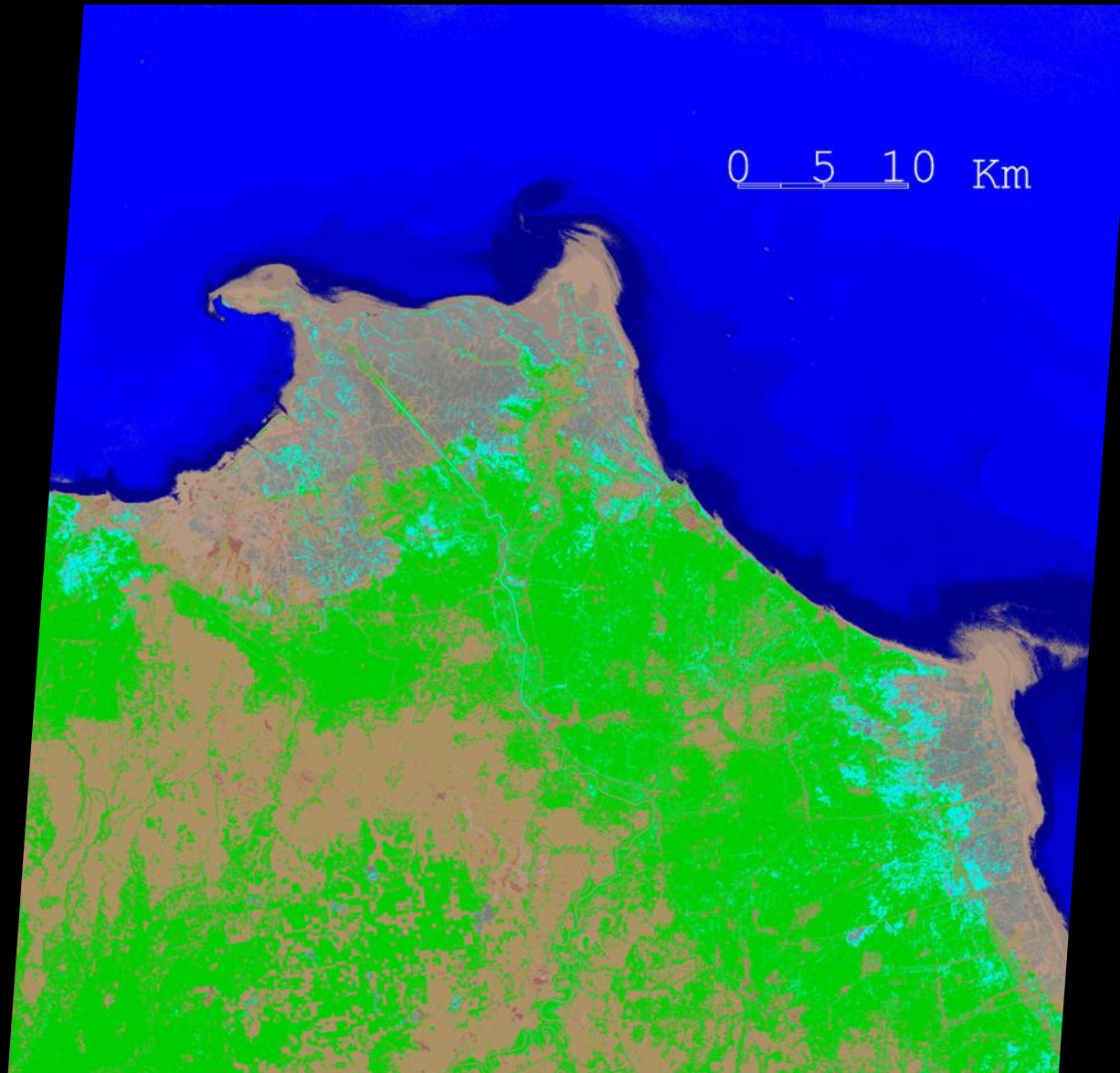
- RNA was extracted from swabs; RT-PCR was conducted for H5N1 genes; antibodies were detected using hemagglutination inhibition and other tests.
- 16% of the captive birds (duck, swan, pigeon, etc.) showed H5N1 antibody.
- Species with the highest seropositive rates in each category are Muscovy duck (captive), striated heron (non-migratory) and Pacific golden plover (migratory).
- Infected captive birds can be asymptomatic.
- The role of migratory birds in H5N1 transmission is limited.



ASTER False-Color, Google Earth And Land Use Maps Around Indramayu



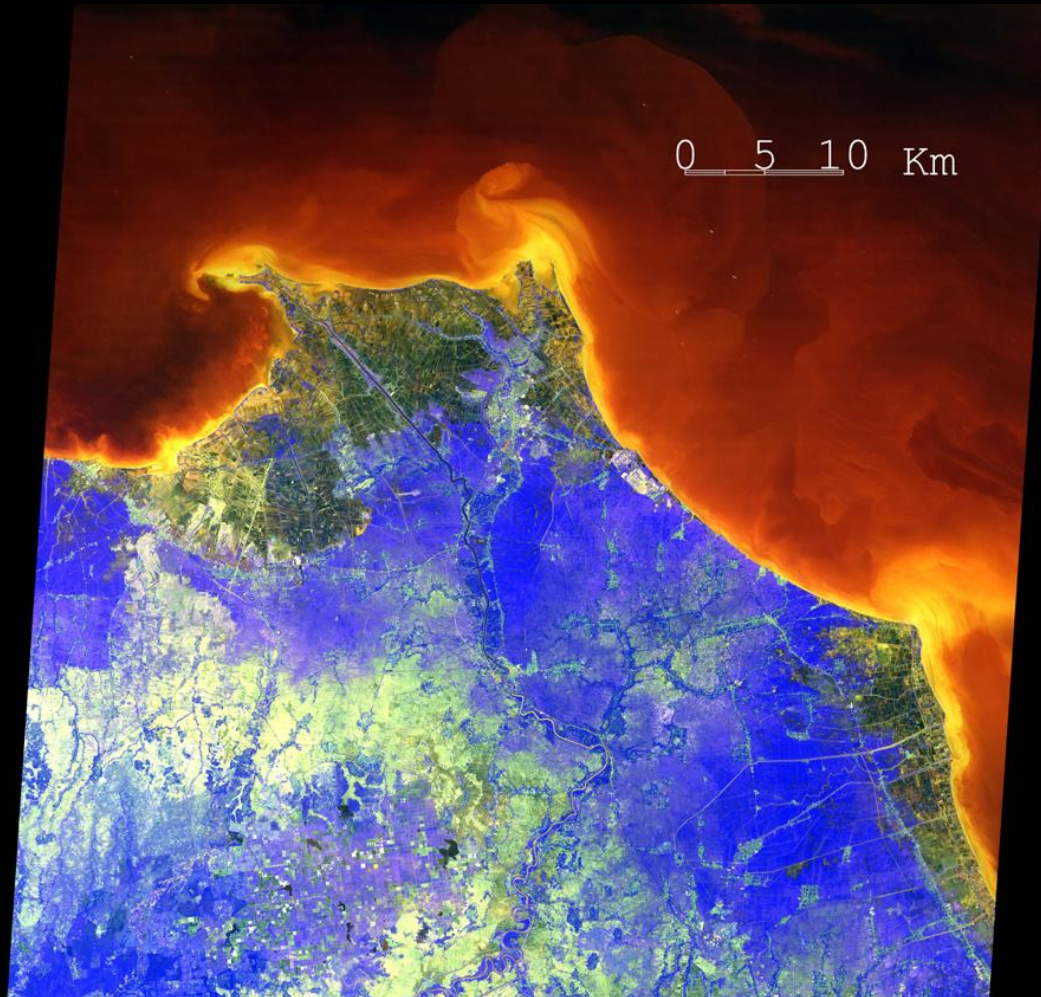
Supervised Classification



Some Bird Species Around Indramayu

Scientific Name	Status		Common Name	Family Name	Migratory / Resident	Location Found	Comments
<i>Hirundo tahitica</i>			Pacific Swallow				It is resident apart from some local seasonal movements
<i>Ixobrychus cinnamomeus</i>			Cinnamon Bittern		Some are migratory		breeding in tropical Asia from Pakistan to Sri Lanka east to China and Indonesia. It is mainly resident, but some northern birds migrate short distances
<i>Lanius schach</i>			Long-tailed shrike		???		a common resident breeder throughout the Indomalayan ecozone from Kazakhstan, through Afghanistan, Pakistan, Indian peninsula except eastern states[2], to New Guinea, found on bushes in scrubby areas and cultivation. Winter visitor to southern areas such as southeast India and Sri Lanka
<i>Leptoptilos javanicus</i>	Vulnerable		Lesser Adjutant		Large bird but not migratory		It is a widespread species which is resident breeder in southern Asia from India east to southern China and Java
<i>Lonchura leucogastroides</i>			Javan Munia				
<i>Lonchura punctulata</i>			Scaly-breasted Munia				
<i>Microhierax fringillarius</i>		App II	Black-thighed Falconet				
<i>Mycteria cinerea</i>	Vulnerable	App I	Milky stork				predominantly coastal resident in Indonesia and Malaysia
<i>Nectarinia jugularis</i>			Asian subbird, olive-backed sunbird				common across southern China to the Philippines and Malaysia down to northeast Australia
<i>Numenius arquata</i>			Eurasian Curlew		migratory		This is a migratory species over most of its range, wintering in Africa, southern Europe and south Asia. Occasionally, a vagrant individual reaches places far away from its normal range, such as Nova Scotia[1] or the Marianas[2]. It is present all year in the milder climate of Ireland, Great Britain and the adjacent European coasts
<i>Numenius phaeopus</i>			Whimbrel		migratory		This is a migratory species wintering on coasts in Africa, South America, south Asia into Australasia and southern North America. It is also a coastal bird during migration Those Whimbrels that visit Singapore breed in Northeast Asia, migrating in winter to India, southern China, Southeast Asia to the Philippines and the Sundas. They migrate with other shorebirds, and often act as a sentinel species. Very wary, Whimbrels are often the first to alert the other birds to danger. Their peak arrival in Singapore is September-November, although a small number may be found throughout the year. Probably because many first year birds may remain in their wintering quarters throughout the summer. During migration, the Whimbrel roosts in mangroves, feeds on mudflats at the tideline with other waders. They may also be found inland, both around wetlands as well as short dry grassland, farmland, golf courses, park
<i>Nycticorax nycticorax</i>			Night heron		??		
<i>Orthotomus cuculatus</i>			Mountain tailorbird		??		
<i>Orthotomus sutorius</i>			Common Tailorbird				This tailorbird is a resident breeder in tropical south Asia from Pakistan and India to south China, and Indonesia. It has also been spotted in Great Britain
<i>Pelargopsis capensis</i>			Stork-billed kingfisher				
<i>Pericrocotus flammeus</i>							

Buffer zones can be established to limit the spread of H5N1 around wetlands and the nearby farmlands



EU's & UK's Practice:

3 km protection zone

10 km surveillance zone

larger restricted zone

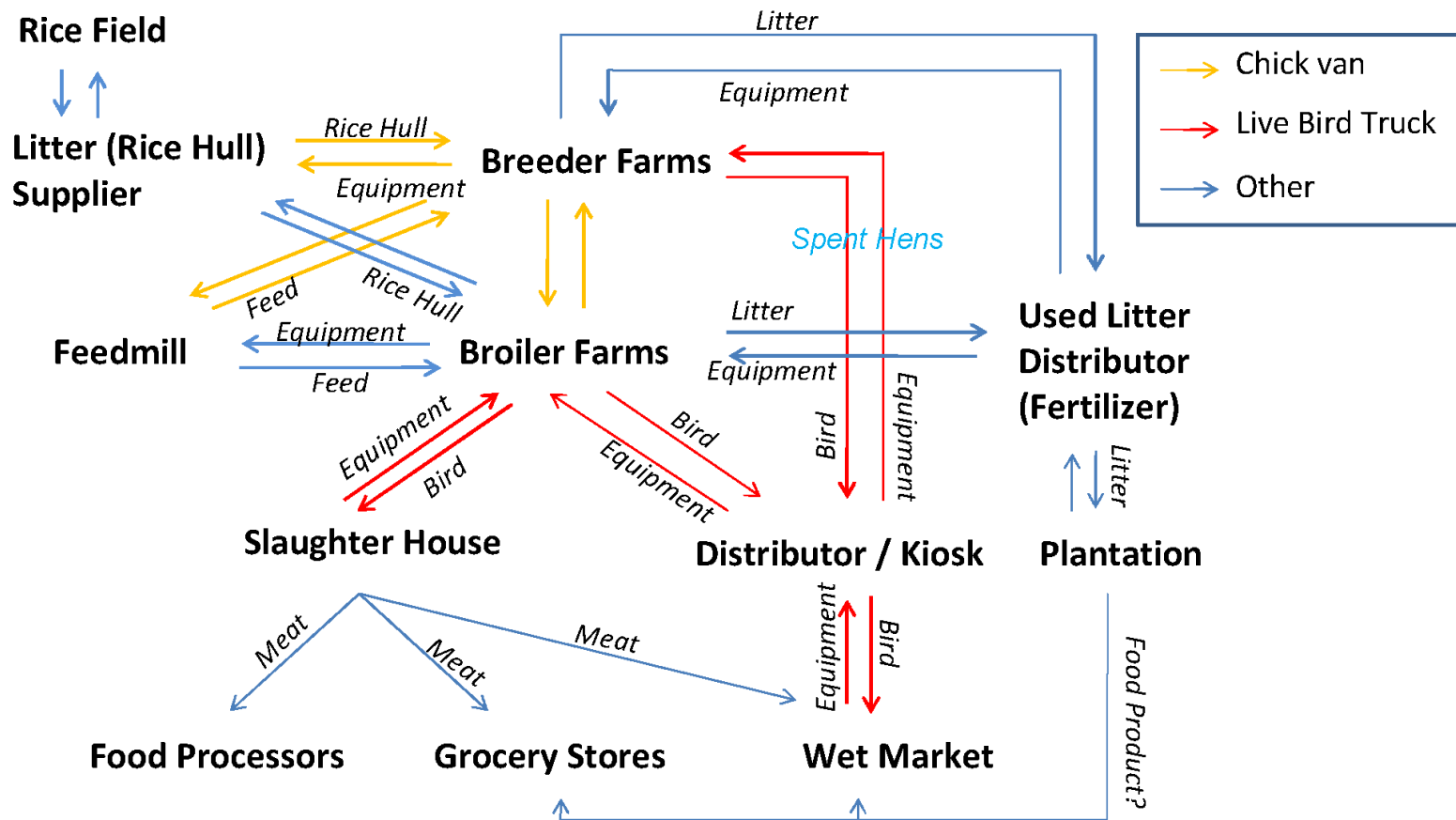
Objective 2

AI Spread in Poultry Production and Trade

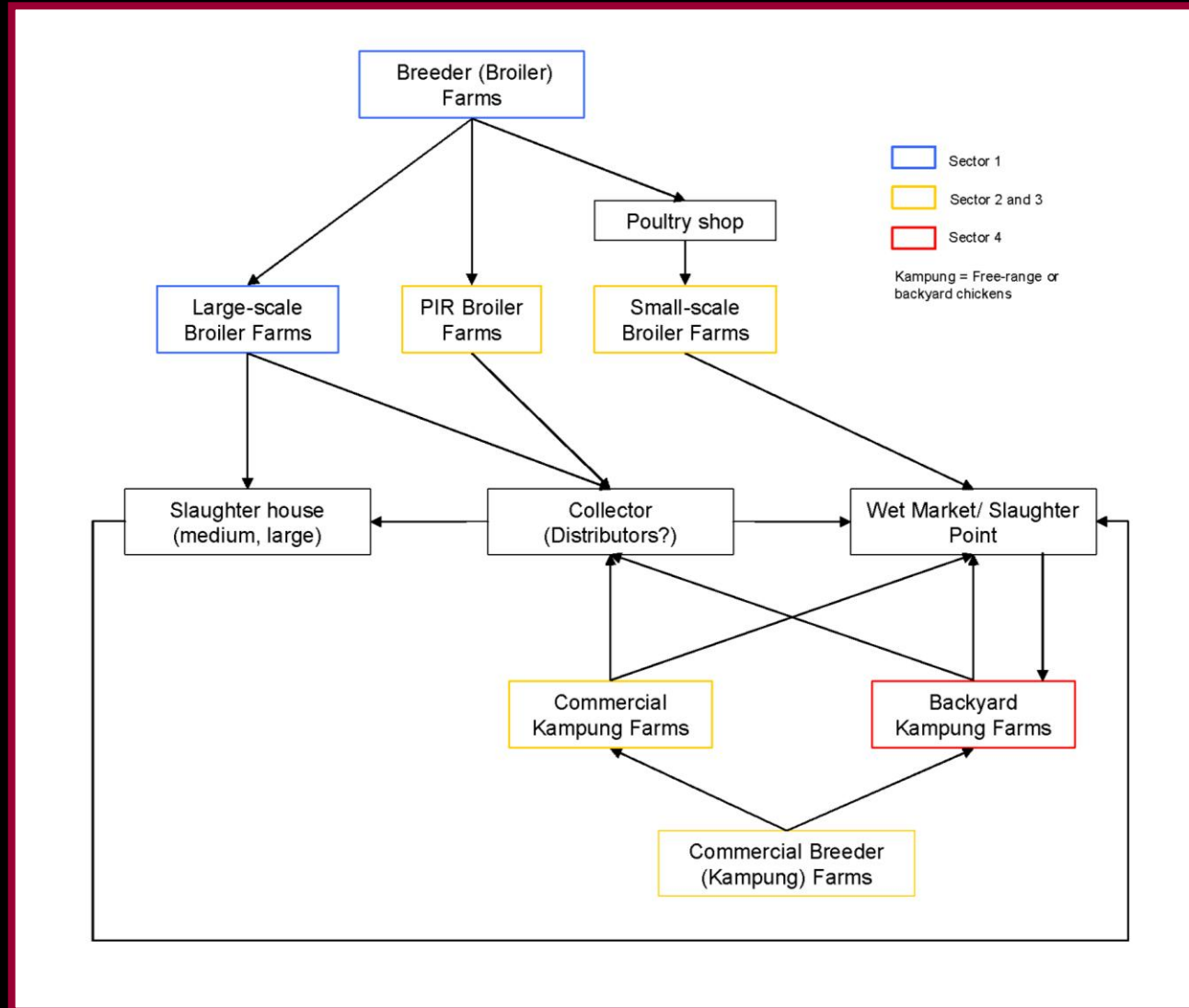
How do AI viruses spread on and off farms, within and across poultry sectors, and into the environment?



On-Farm and Off-Farm Spread of H5N1



Within and Across-Sector Spread of H5N1

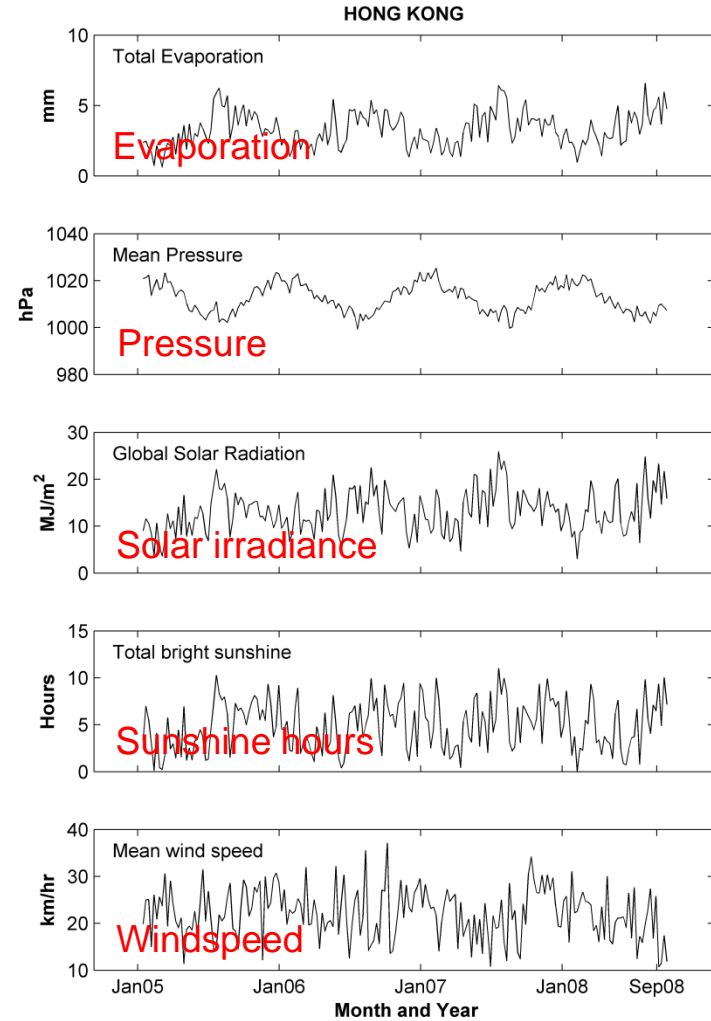
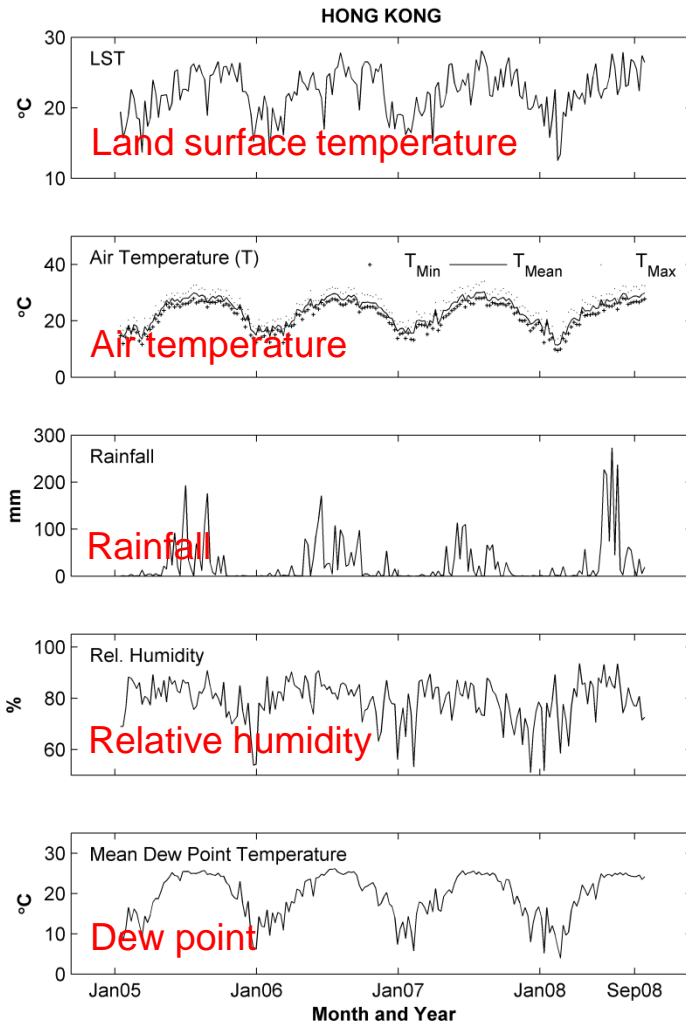


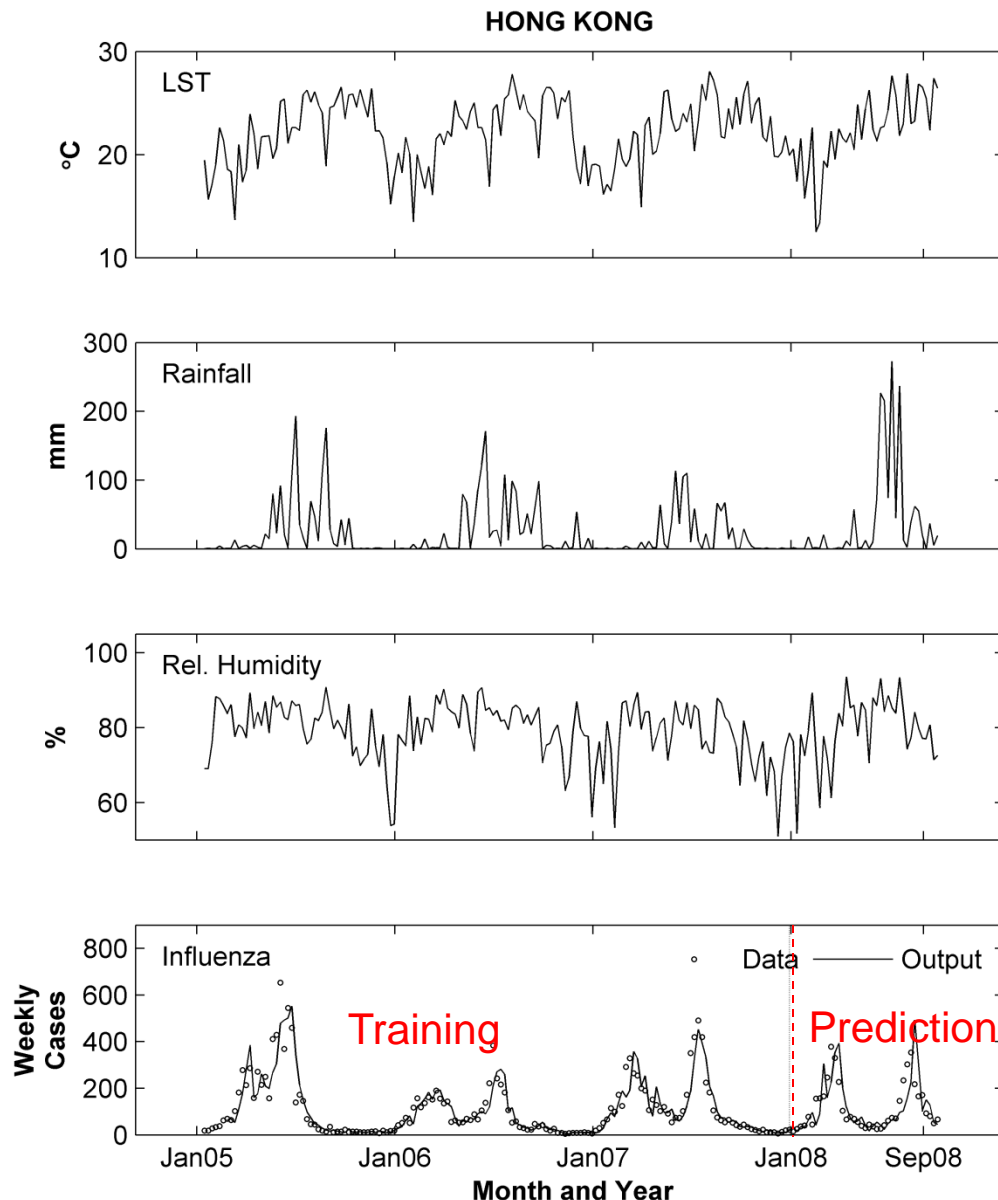
Objective 4

Modeling Human Influenza

How seasonal flu transmission is influenced by the environment, and how can this be used for pandemic early warning?

Hong Kong

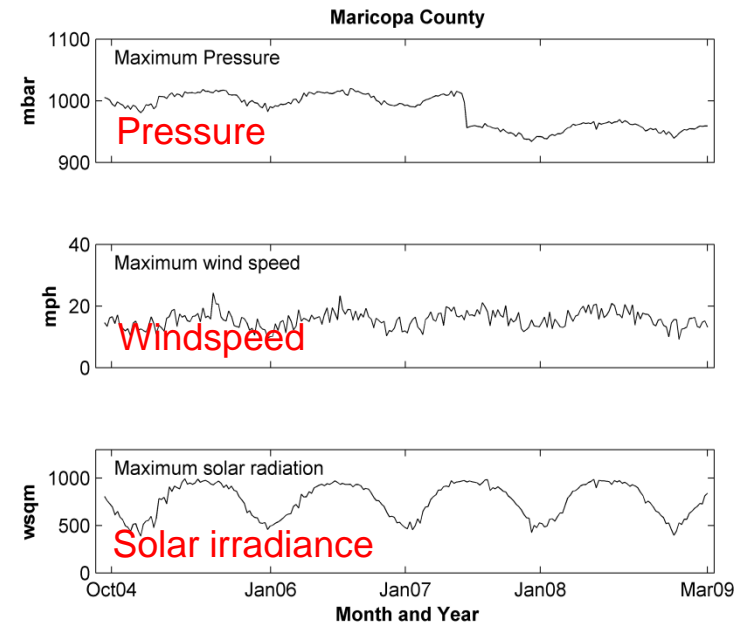
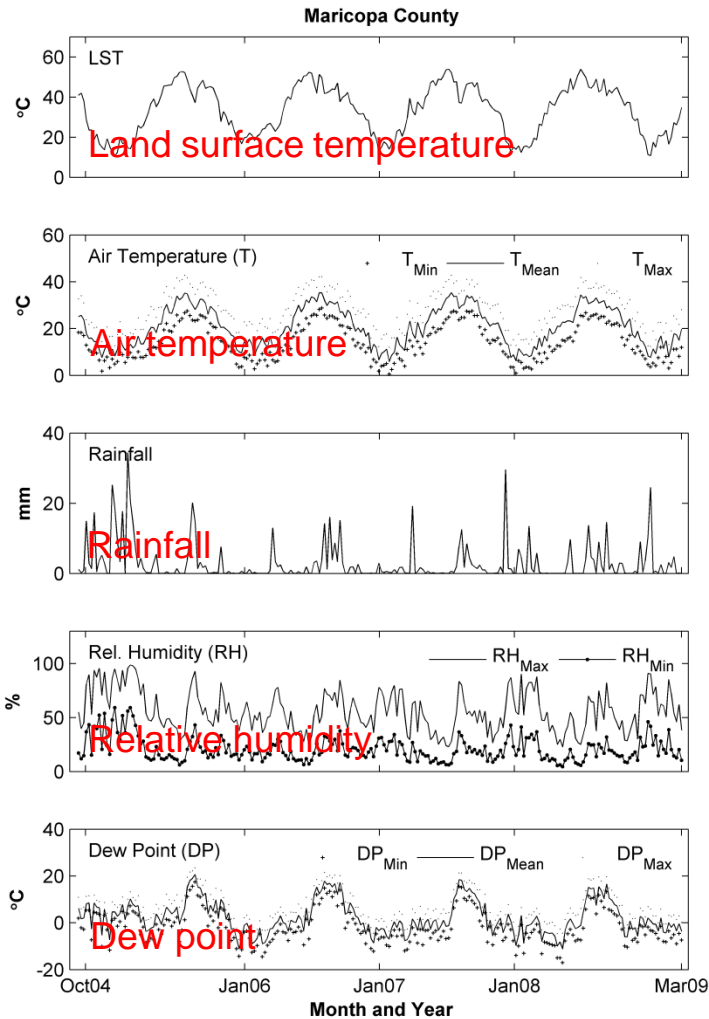




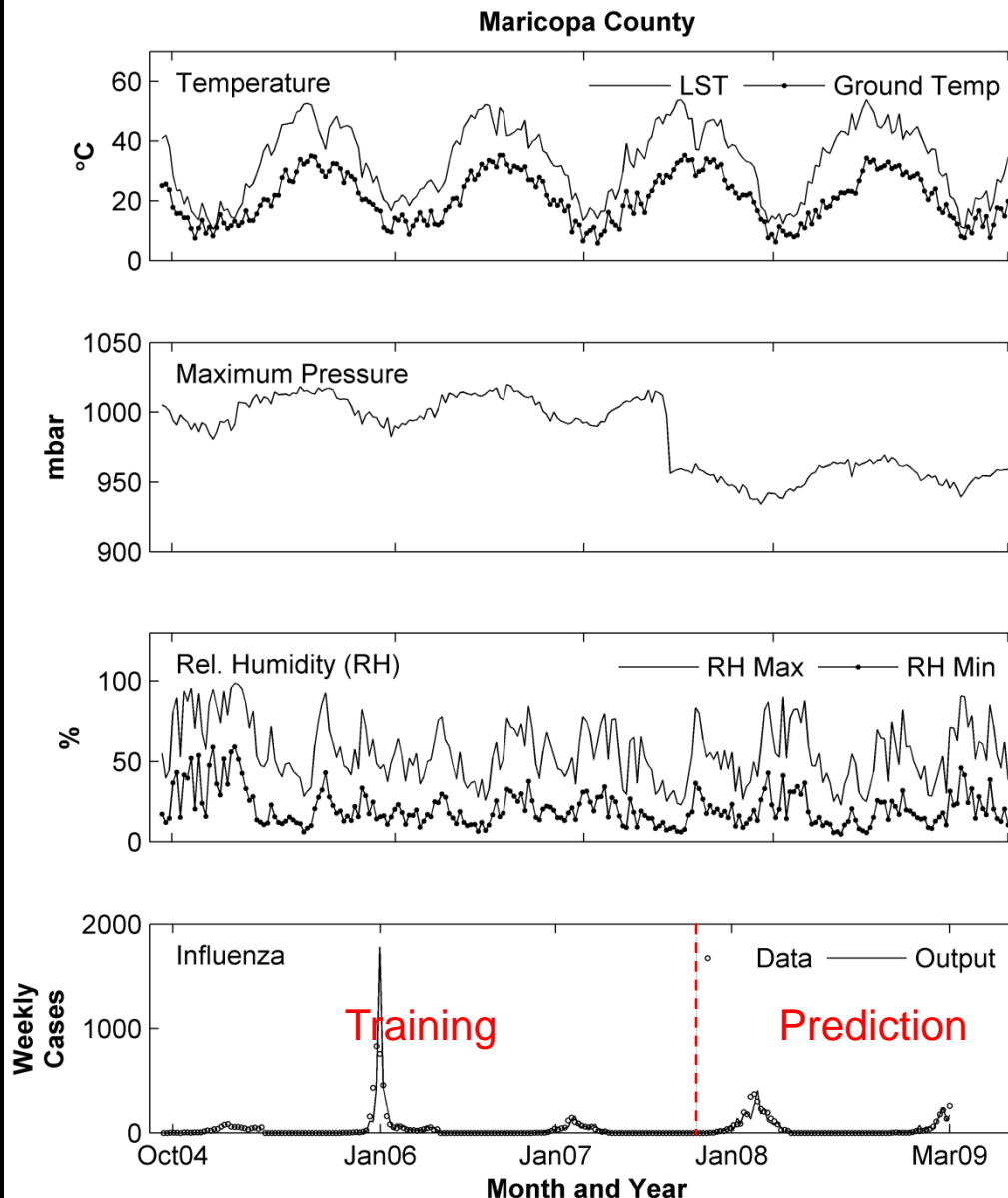
Hong Kong

Time series for
environmental
parameters and
weekly seasonal
influenza cases

Maricopa County, Arizona



Maricopa County, Arizona



Thank You!