Remote Sensing, Ecological Variables and Bird Migration

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Global distribution of H5N1 outbreaks
2003-2006

Bird migration
- important for understanding the role of wild waterbirds in the spread of H5N1 virus
- a long history of in-situ field observations, but limited geospatial databases at continental to global scales

A changing Planet Earth poses challenge for bird migration
- land use change
  - loss of wetlands
  - agricultural expansion and intensification
  - post-harvest management
  - water use change (e.g., fish and shrimp ponds, dams)
- climate change

Bird migration and climate change
Qinghai - Tibet plateau
the roof-of-the-world, 2.5 million km²
breeding sites for wild birds
temperature rise by ~0.9°C since 1980s
Increase in thawing of permafrost
Decrease in glacier area by 7% per year
→ increase in surface water bodies
Early onset of Indian summer monsoon

Climate variation/change calls for re-analysis of bird migration and climate data.
Satellite remote sensing provides routine observations for quantifying ecological variables relevant to bird migration.

Land sat 7
12/27/99

MODIS
Red/Green/Blue (band 1-4-3) 5/25-6/1, 2002
Tonle Sap, Mekong Delta (Cambodia / Viet Nam)
500-m spatial resolution

Bird migration and satellite remote sensing

1. Phenology of waterbirds migration
timing of migration

Ecological variables that trigger migration

2. Land surface phenology and ecosystems
Habitats along migratory flyway
breeding, stop-over, moulting and wintering sites

3. Satellite remote sensing track ecological variables and habitats for migratory birds

Phenology of waterbirds migration

Ecological variables that trigger bird migration in autumn (seasonal migration)

Temperature (e.g., frost)
Snow, Ice
Wind

Traveling wave of the first frost in July – Dec. 2005 (nighttime LST from MODIS/Aqua)

Phenology of waterbirds migration

Ecological variables that trigger bird migration in spring (seasonal migration)

Temperature (e.g., frost)
Snow and Ice (melting)
Wind

Traveling wave of the last frost in Jan - June 2005 (nighttime LST from MODIS/Aqua)
Ecological variables that affect bird migration in autumn and spring (seasonal migration)
- onset of wet & dry seasons

Tropical Rainfall Measuring Mission (TRMM)

- Monthly rainfall at 0.5° grid

Land surface phenology and ecosystems
In a human-dominated Earth, changes in land use and water use have substantially altered ecosystems both spatially and temporally, which may affect migratory flyway (breeding, stop-over, moulting and wintering sites). Wild waterbirds may use croplands as part of their habitats.

- Ecosystems along the “migration flyway”
- Land surface phenology
- Rural landscape where wild birds interact and mix with domestic poultry

Where do wild waterbirds fly to and stay?

Southeast Asia in 2004

- MODIS-based land surface phenology
- H5N1 outbreaks in Thailand

H5N1 outbreaks in Thailand and Vietnam were concentrated in those areas with multiple cropping systems.

Role of satellite remote sensing

Satellite-based geospatial datasets

1. Agricultural land use
   - cropping intensity, calendar & irrigation

2. Wetlands
   - natural wetlands, water bodies

3. Climate
   - water & land surface temperature, snow, ice, wind, drought, rainfall

- migration timing, survival rates of HPAIV
Summary

1. Geospatial data of climate, agro-ecosystems, natural wetlands are needed in order to better understand bird migration.

2. Satellite remote sensing can provide such geospatial datasets in timely mode.

3. Integrating the geospatial databases with bird migration data (in-situ, satellite-tracking) will improve geospatial analysis of bird migration, which would help understand the role of migratory birds in the spread of HPAI virus, and identify likely “hot spots” and “hot times” for risk assessment and targeted surveillance.

Framework of observations, analysis and modeling

Thank you!