# K&C Irrigated Rice Products:

# Understanding the influence of rice paddies on atmospheric $CH_4$

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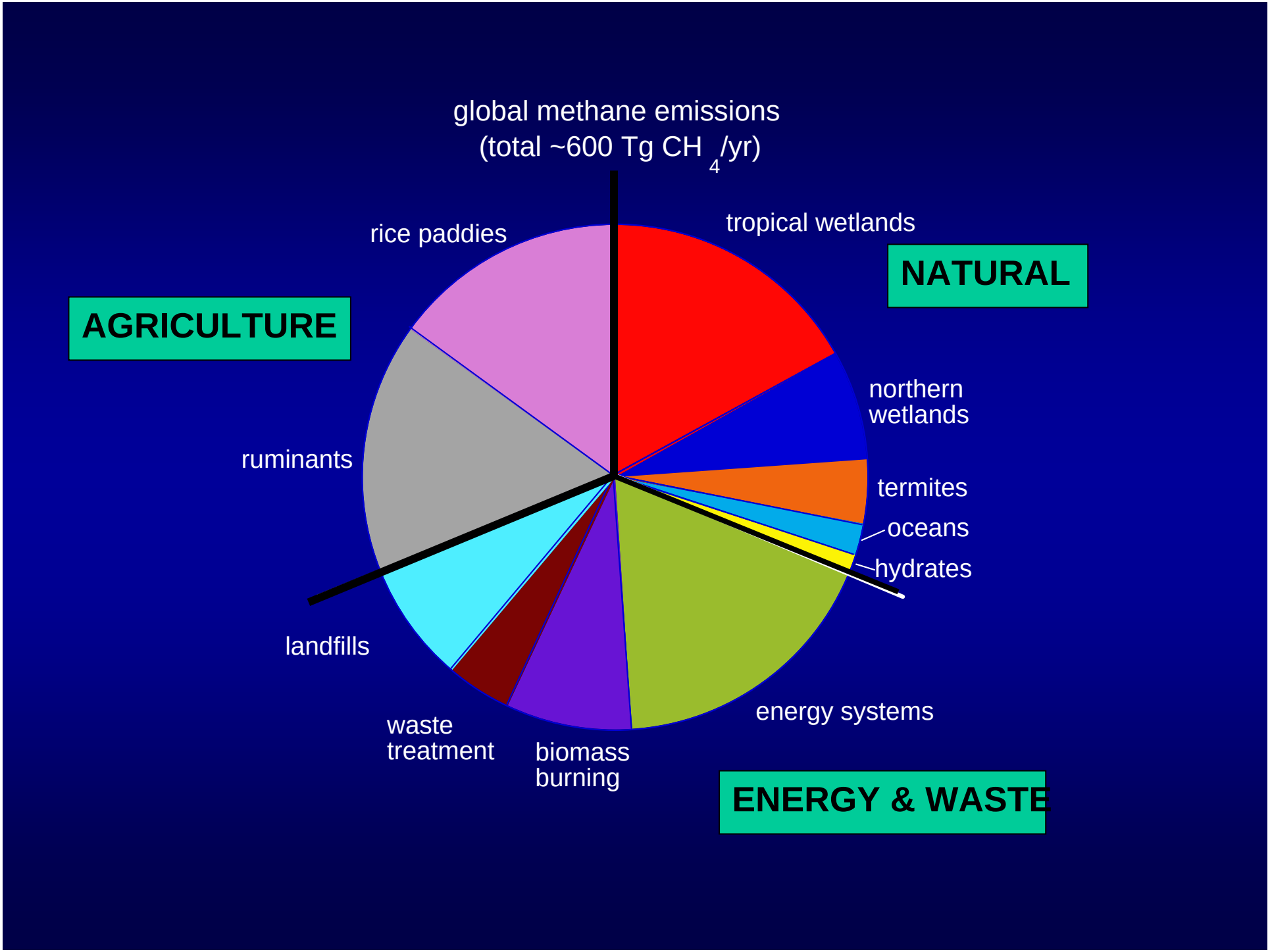
Applied Geosolutions, LLC

K&C Initiative, 7th Science Advisory Panel Meeting, January 2007

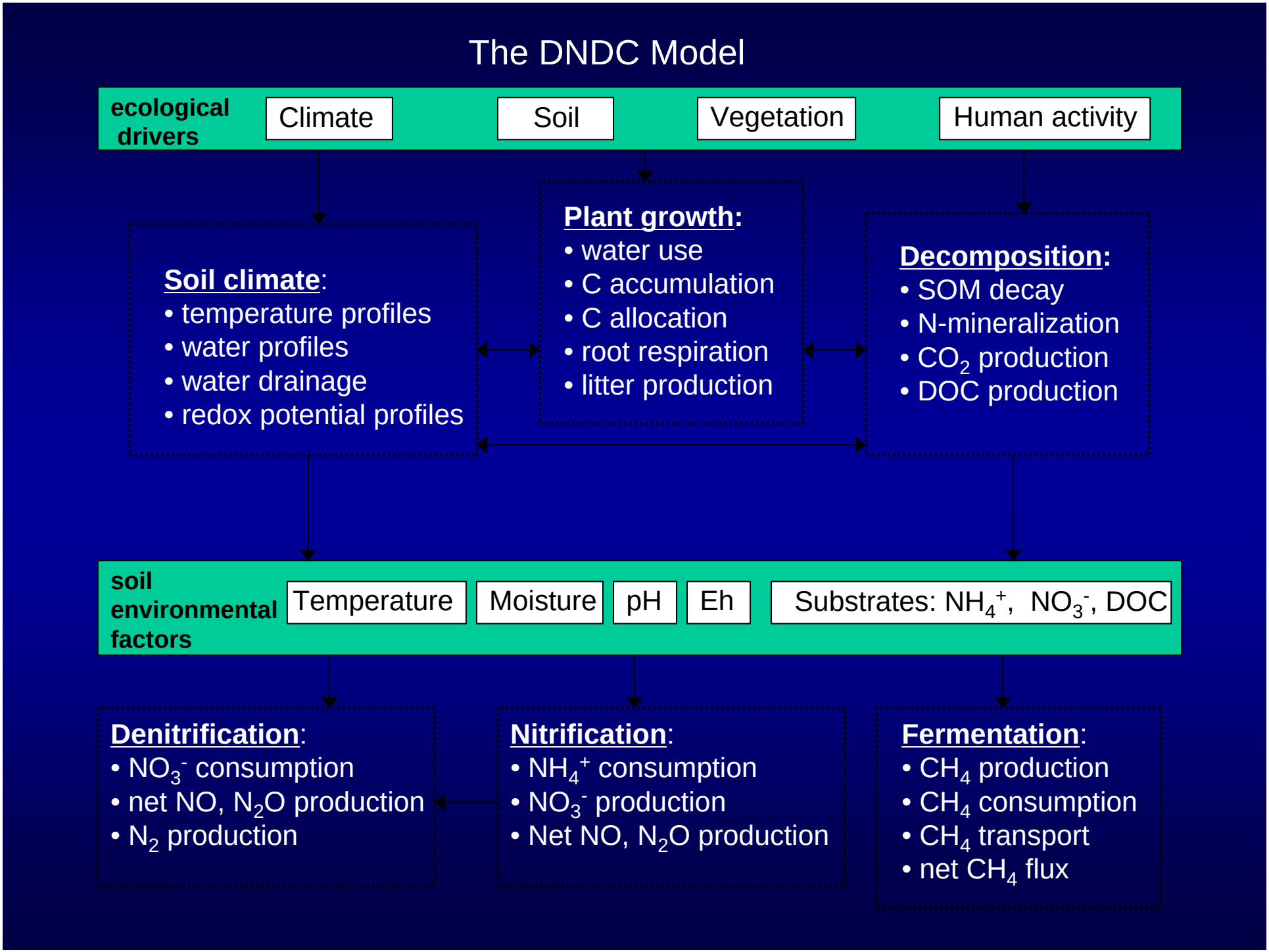

global methane emissions
(total ~600 Tg CH 4 /yr)
tropical wetlands
NATURAL
rice paddies
AGRICULTURE
northern
wetlands
ruminants
termites
oceans
hydrates
landfills
energy systems
waste
treatment
biomass
burning
ENERGY & WASTE

***"Assessing the influence of Asian rice paddies on the growth rate of atmospheric methane 1980-2020"***

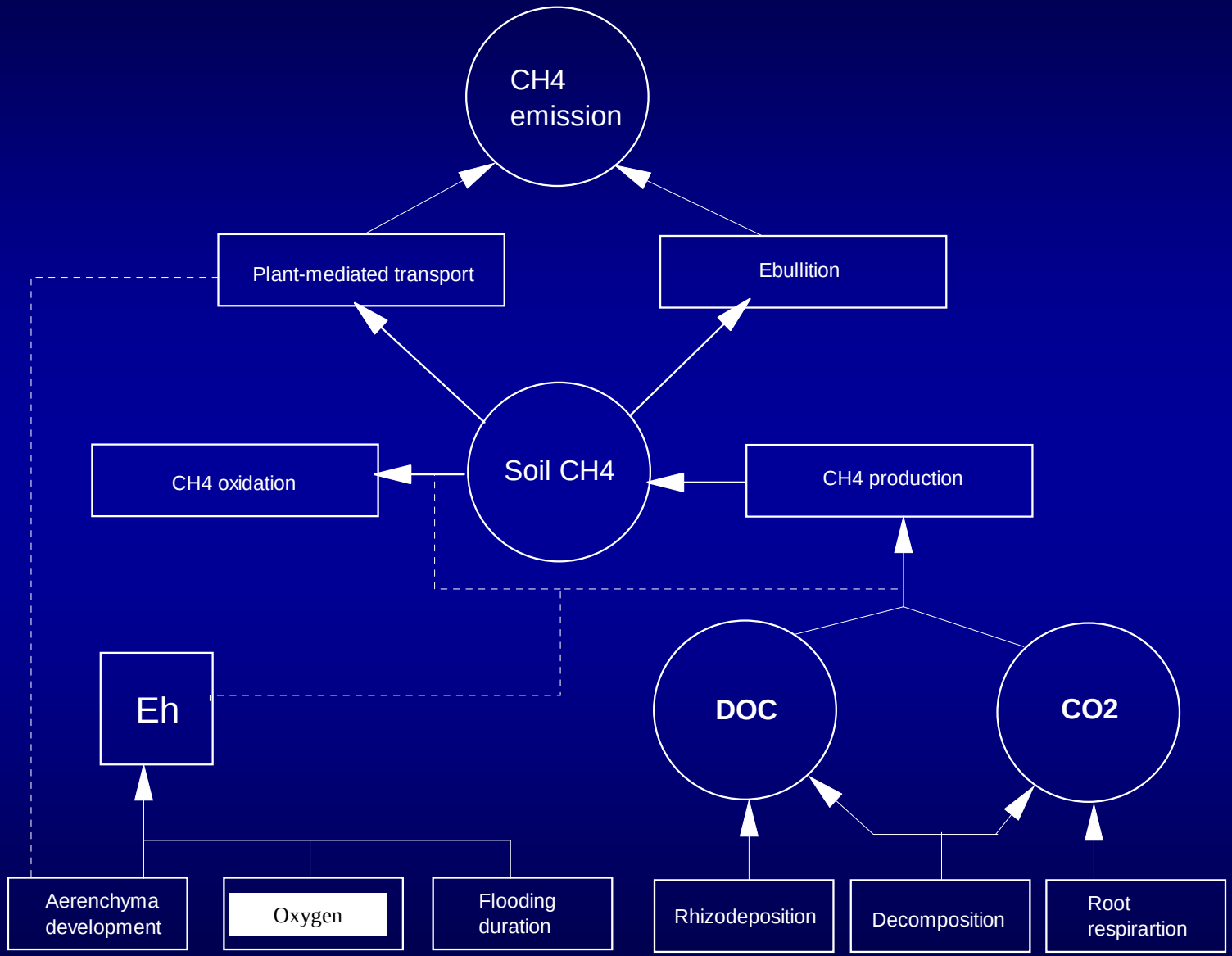
*Biogeochemical modeling* - improving DNDC model for diverse Asian rice conditions

*GIS Database Development* - spatial data (climate, soil, etc.) used as input to DNDC

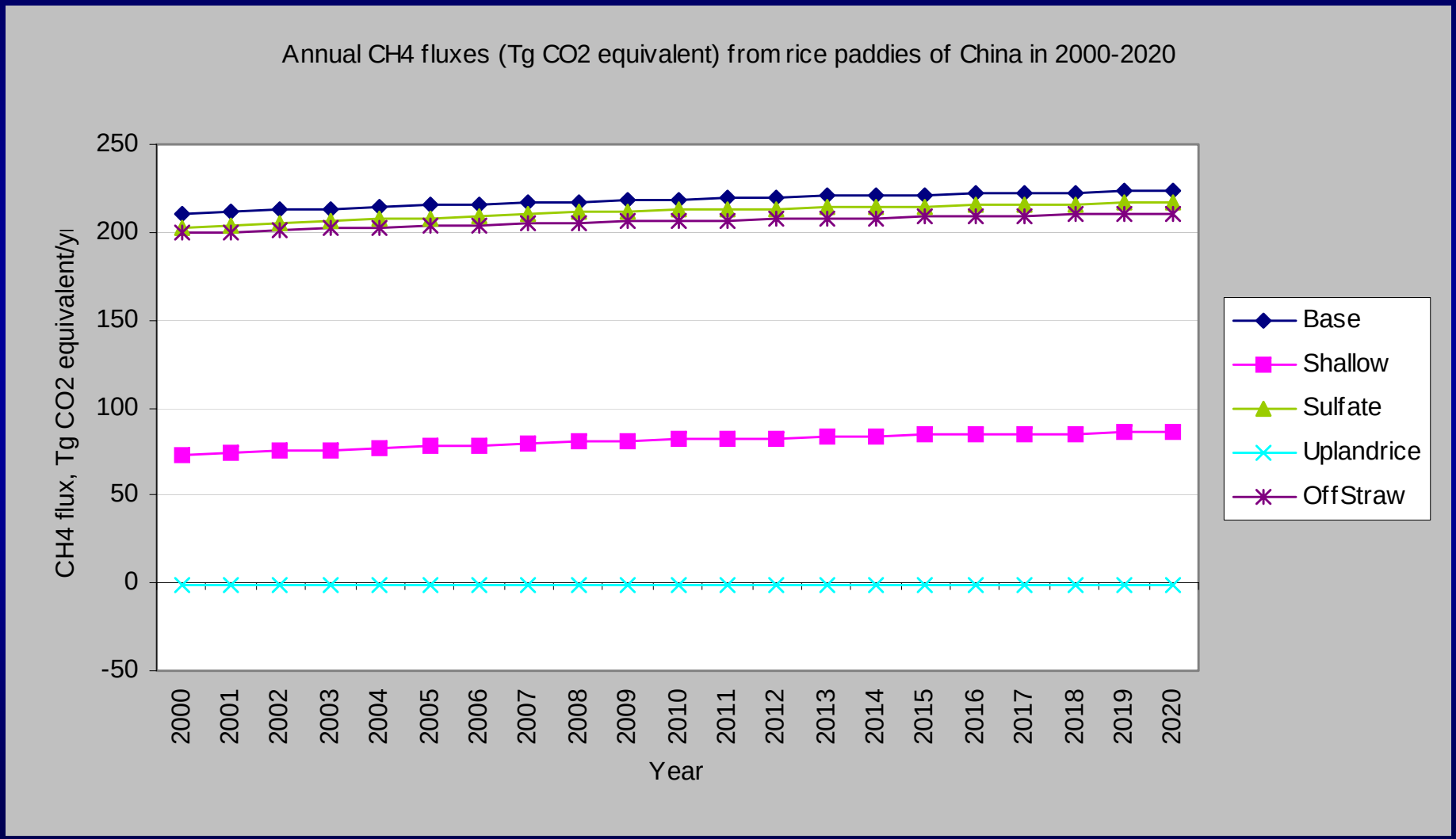

*Remote Sensing Analysis* - mapping rice location, phenology, and water management using RS (MODIS, PALSAR) data


The DNDC Model
ecological drivers
Climate
Soil
Vegetation
Human activity
Soil climate:
• temperature profiles
• water profiles
• water drainage
• redox potential profiles
Plant growth:
• water use
• C accumulation
• C allocation
• root respiration
• litter production
Decomposition:
• SOM decay
• N-mineralization
• $CO_2$ production
• DOC production
soil environmental factors
Temperature
Moisture
pH
Eh
Substrates: $NH_4^+$, $NO_3^-$, DOC
Denitrification:
• $NO_3^-$ consumption
• net NO, $N_2O$ production
• $N_2$ production
Nitrification:
• $NH_4^+$ consumption
• $NO_3^-$ production
• Net NO, $N_2O$ production
Fermentation:
• $CH_4$ production
• $CH_4$ consumption
• $CH_4$ transport
• net $CH_4$ flux

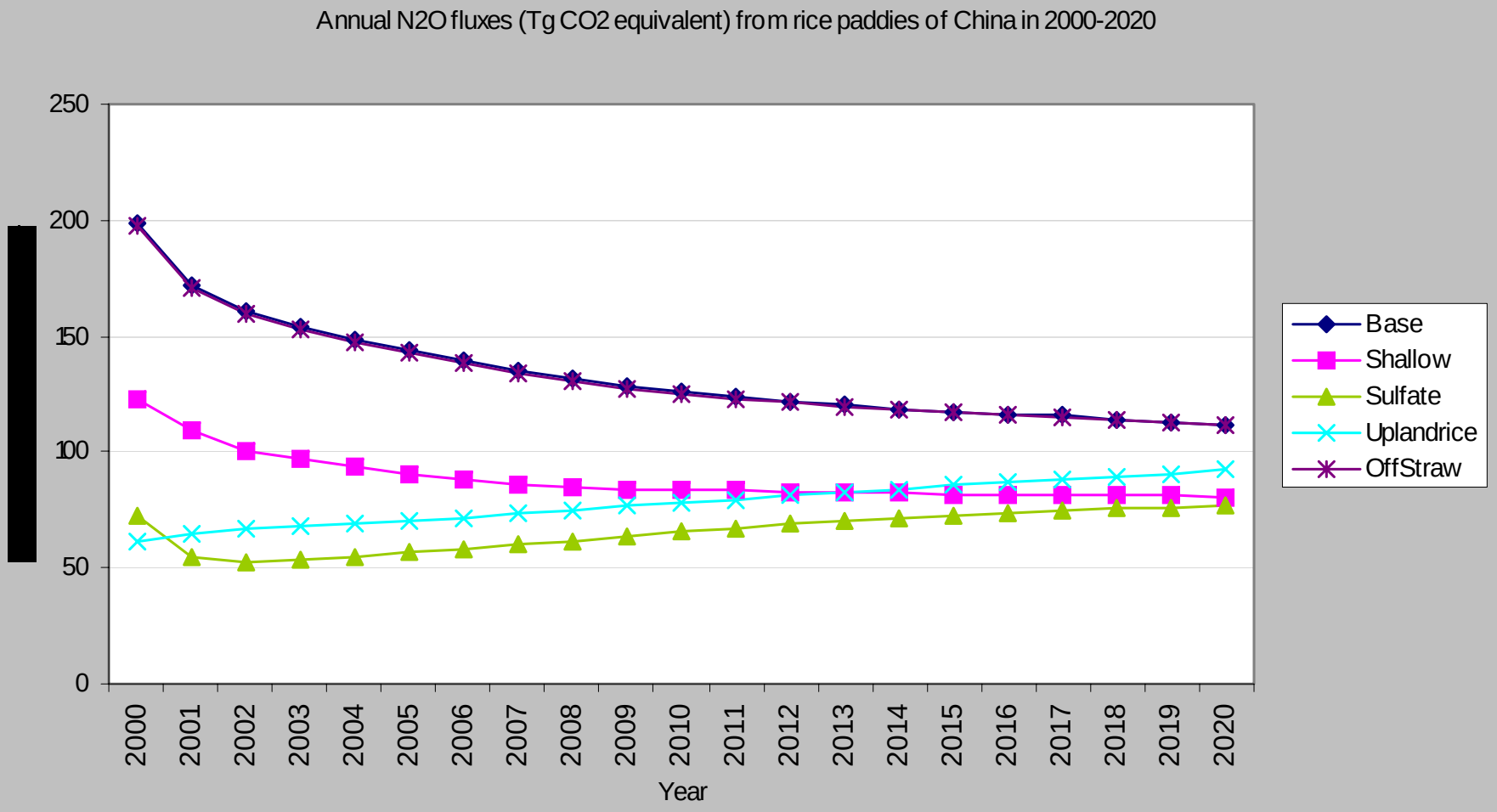
# DNDC: Modeling CH4 emissions from rice paddy



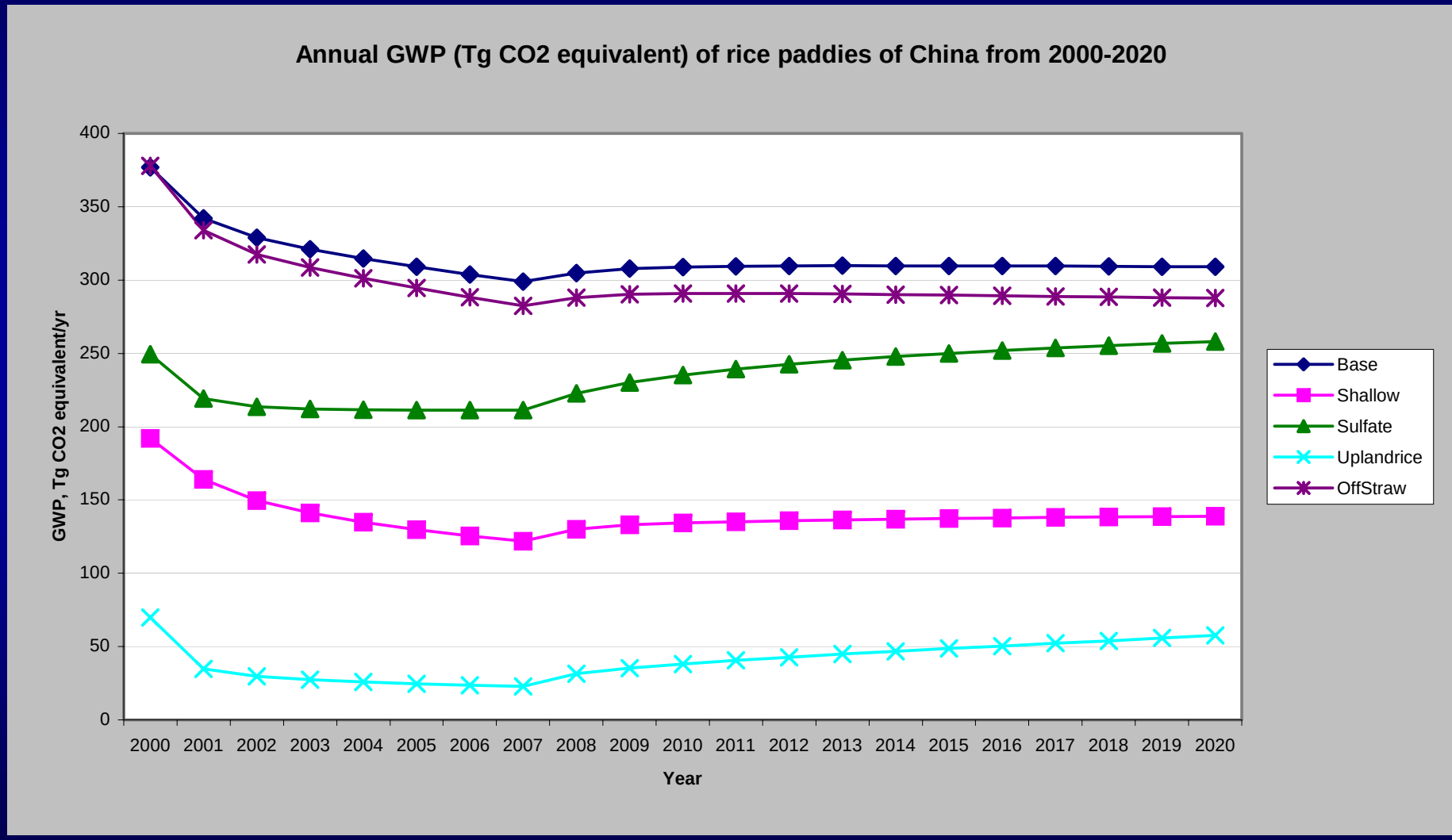
# Annual $CH_4$ Fluxes (Tg $CO_2$Eq)



# Annual $N_2O$ Fluxes (Tg $CO_2$Eq)



# Annual Net GWP (Tg $CO_2$Eq)



# Role of Agricultural Management Observatory

- While statistical data on agricultural management exist, they are not sufficient for geospatial decision support systems.
- Critical need for spatially explicit information on
  - crop type,
  - crop phenology,
  - tillage practices,
  - residue management, etc.

# MODIS DATA PROCESSING

*Green-sensitive vegetation indices:*

NDVI

$$NDVI = \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}}$$

EVI

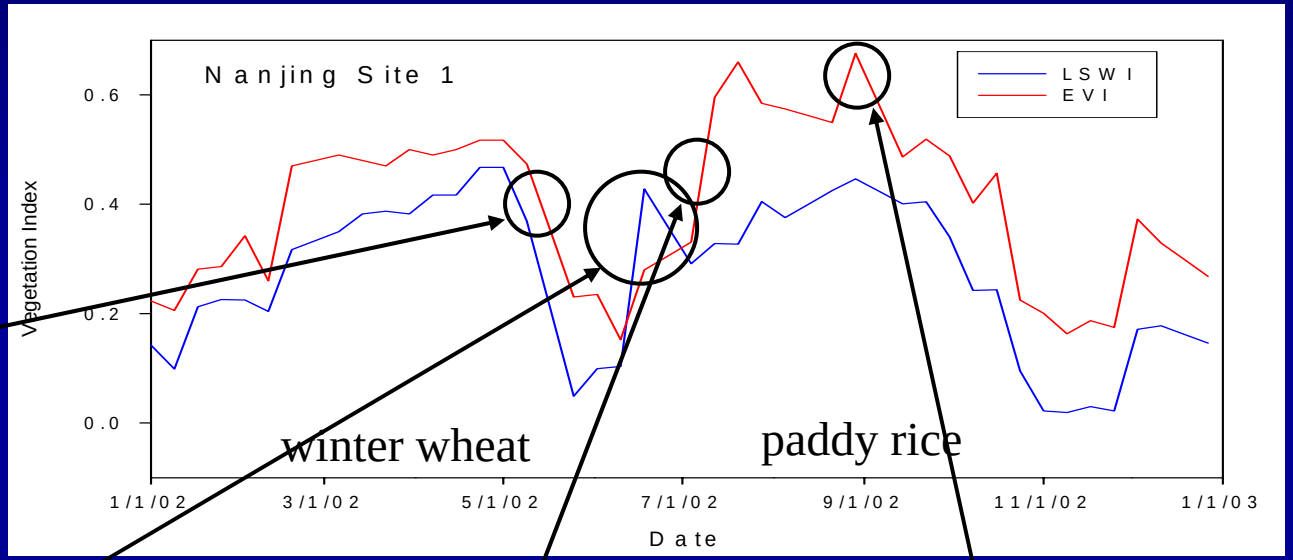
$$EVI = 2.5 * \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + 6 * \rho_{red} - 7.5 * \rho_{blue} + 1}$$

*Water-sensitive vegetation index:*

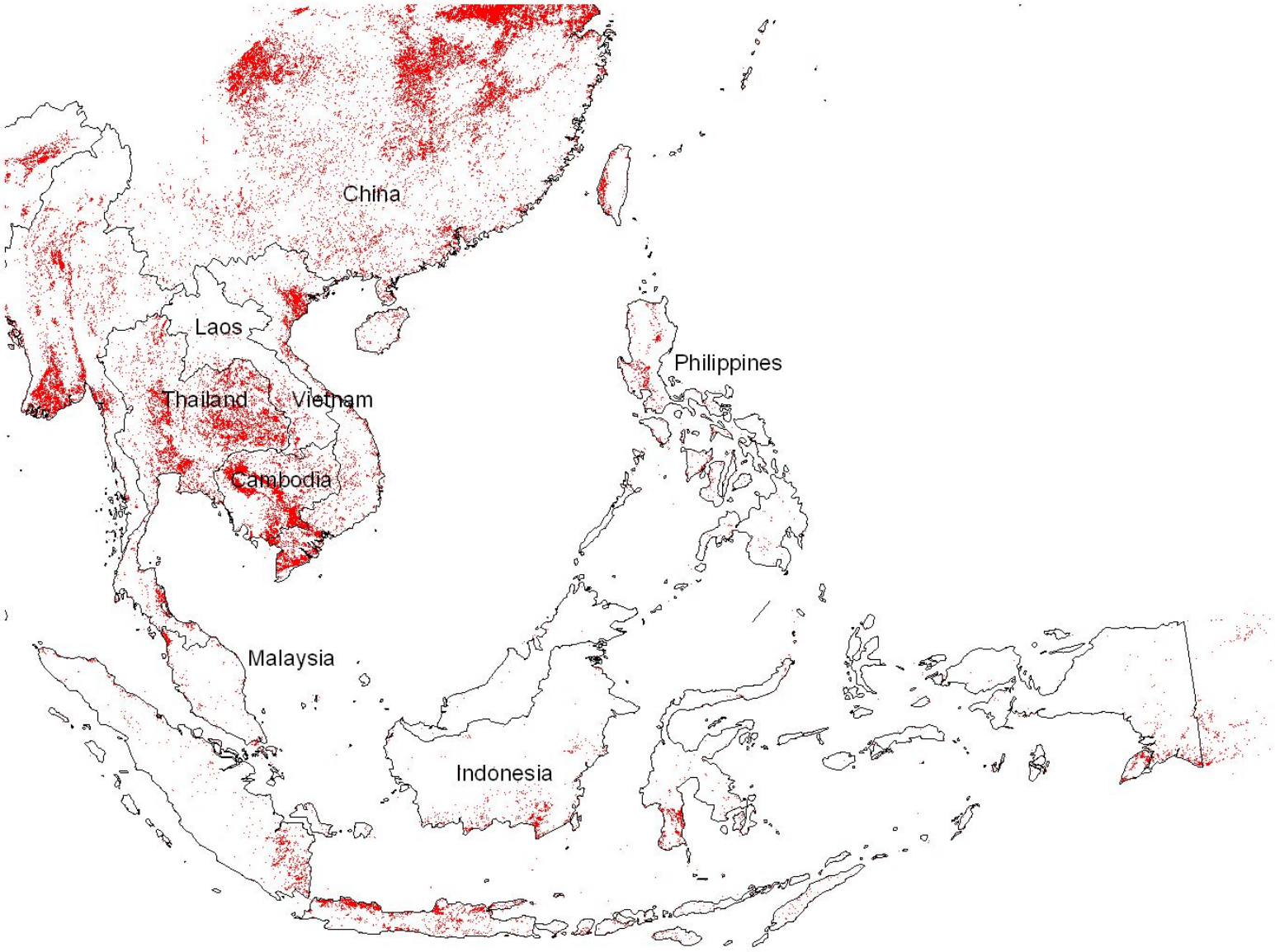
LSWI

$$LSWI = \frac{\rho_{nir} - \rho_{swir}}{\rho_{nir} + \rho_{swir}}$$

# MAPPING RICE – THE LOGIC



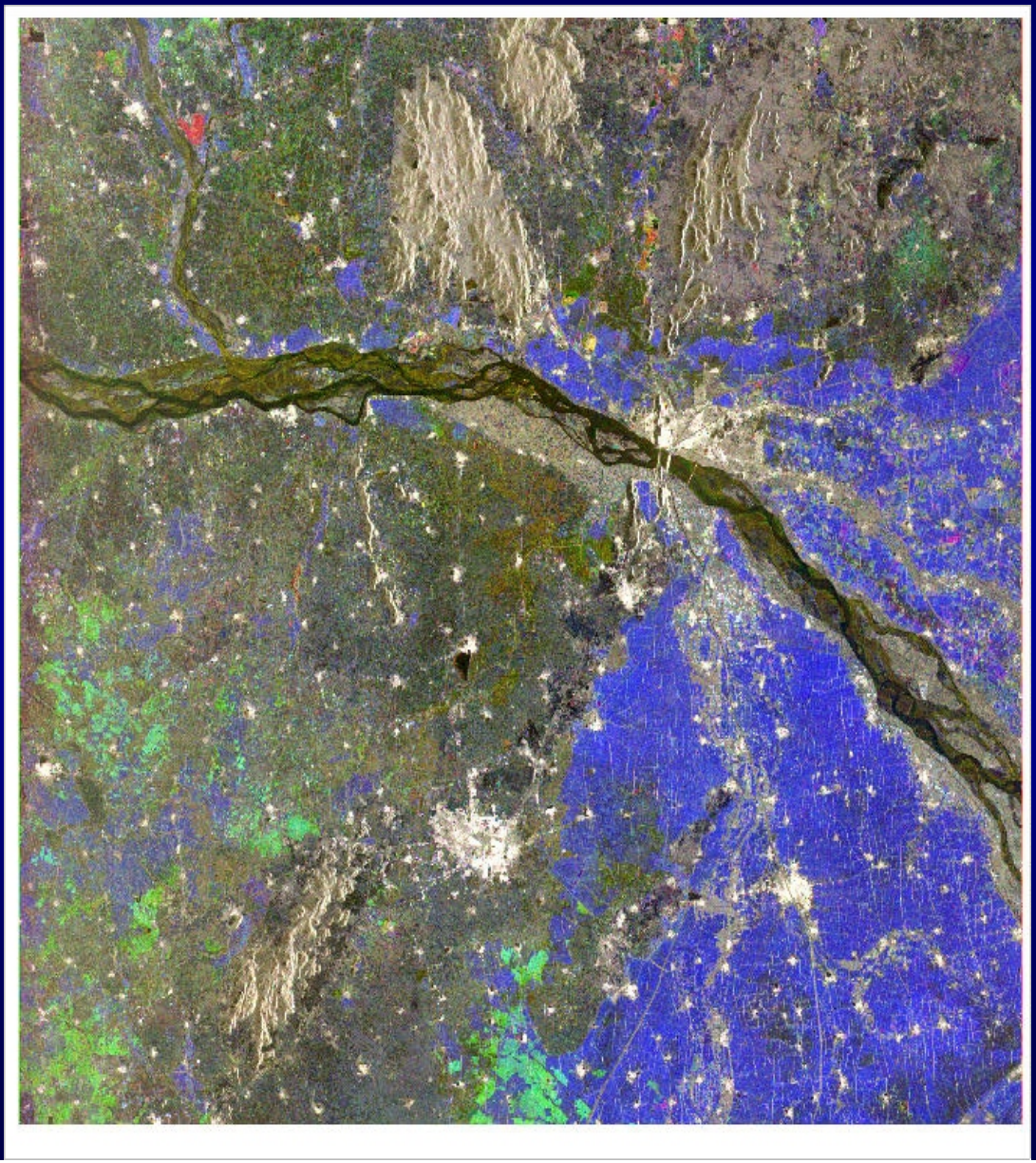

# MODIS-derived paddy rice area, Southeast Asia, 2002



# Need for SAR…Issues with MODIS

- Cloudy, even through we are using 8-day composites, difficulty with persistent clouds
- Resolution: 500m SWIR band.
- Water management: mid-season drainage and shallow flooding

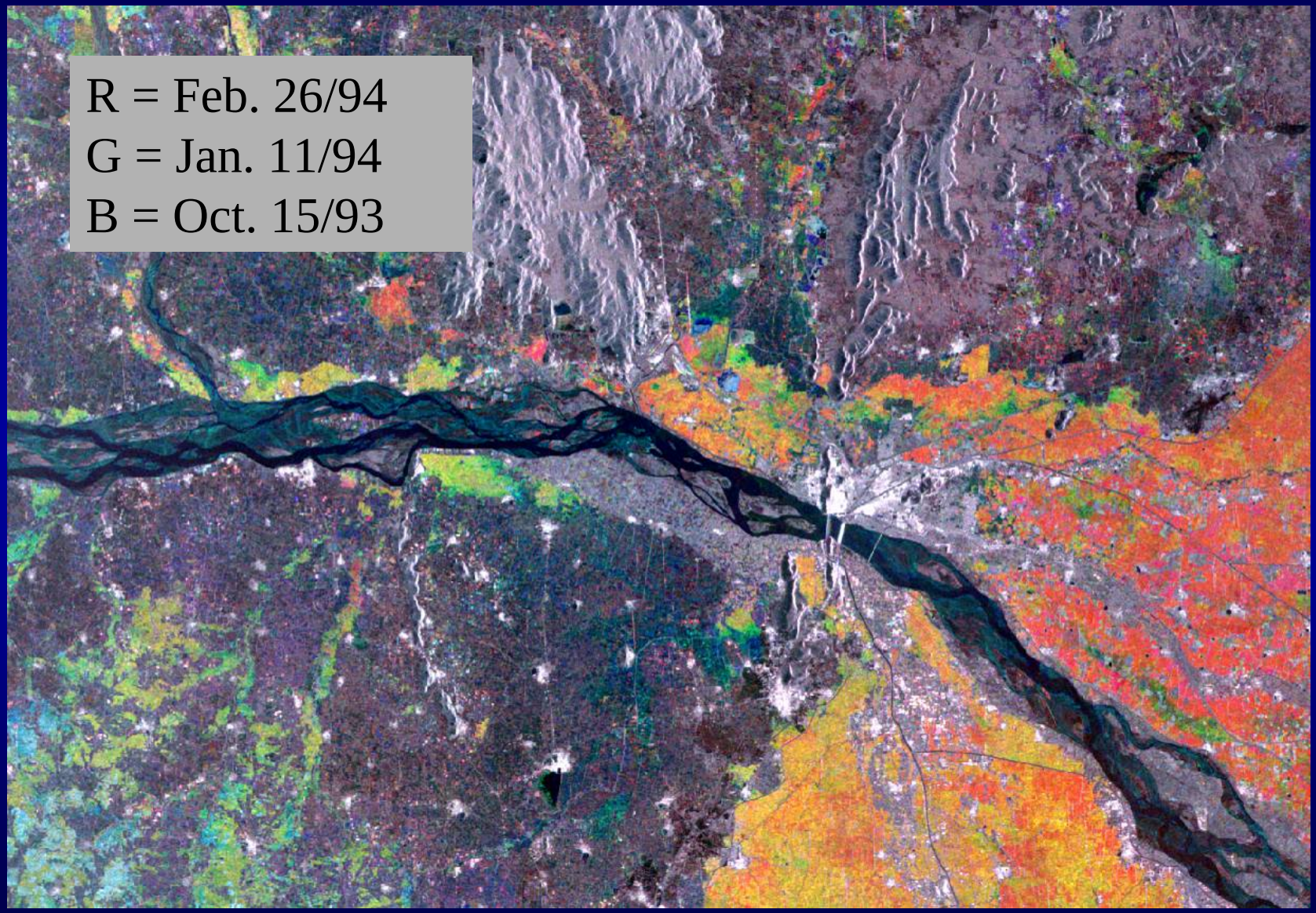
# Mapping Cropping Systems in India Example



JERS-1 composite – Vijayawada area

Both blue and green shades represent rice paddies
BLUE = rabi crop
GREEN = kharif crop

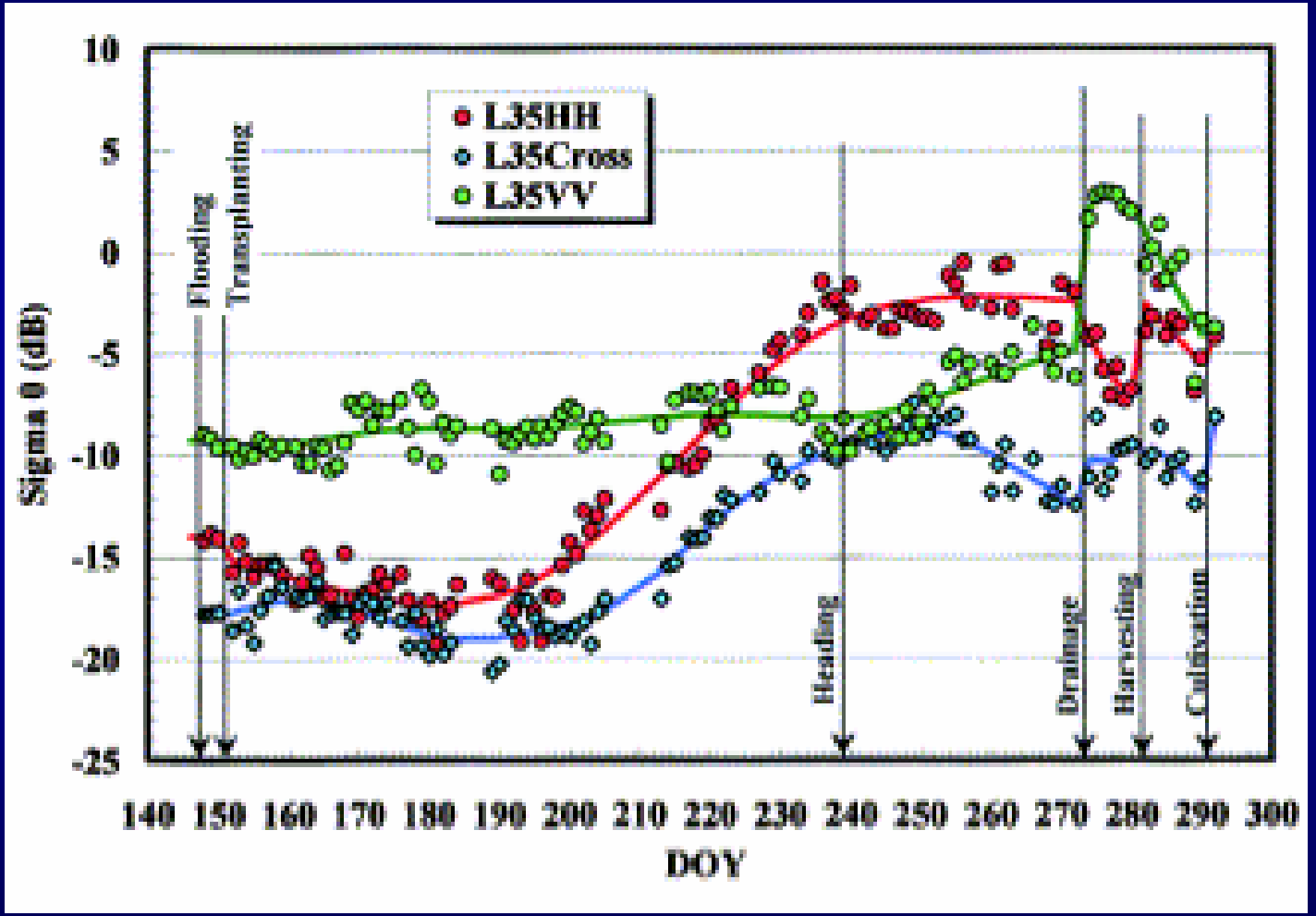
# JERS SAR Rice Mapping: India Example



# K&C Irrigated Rice Products

- *Data: PALSAR ScanSAR time series*
- *"Routine"*:
  - ***Paddy Extent***. Coverage to include all of Asia (China, India, SE Asia) which includes 90% of total rice area globally.
  - ***Crop cycles/phenology.*** Map single-, double-, triple-rice and rice/upland double cropping.
  - ***Flood Duration***. Period of inundation
- "Research":
  - ***Biomass/LAI development.*** Track biomass/LAI development.
  - ***Mid-season drainage.*** Quantify the presence of mid-season drainage.

# Temporal Changes in L-band Sigma 0




Source: Inoue et al. 2002

## Source of Funding?

# Ecology and Risk Factors of Highly Pathogenic Avian Influenza in Asia

## --- Cropland, Poultry and Wild Waterfowls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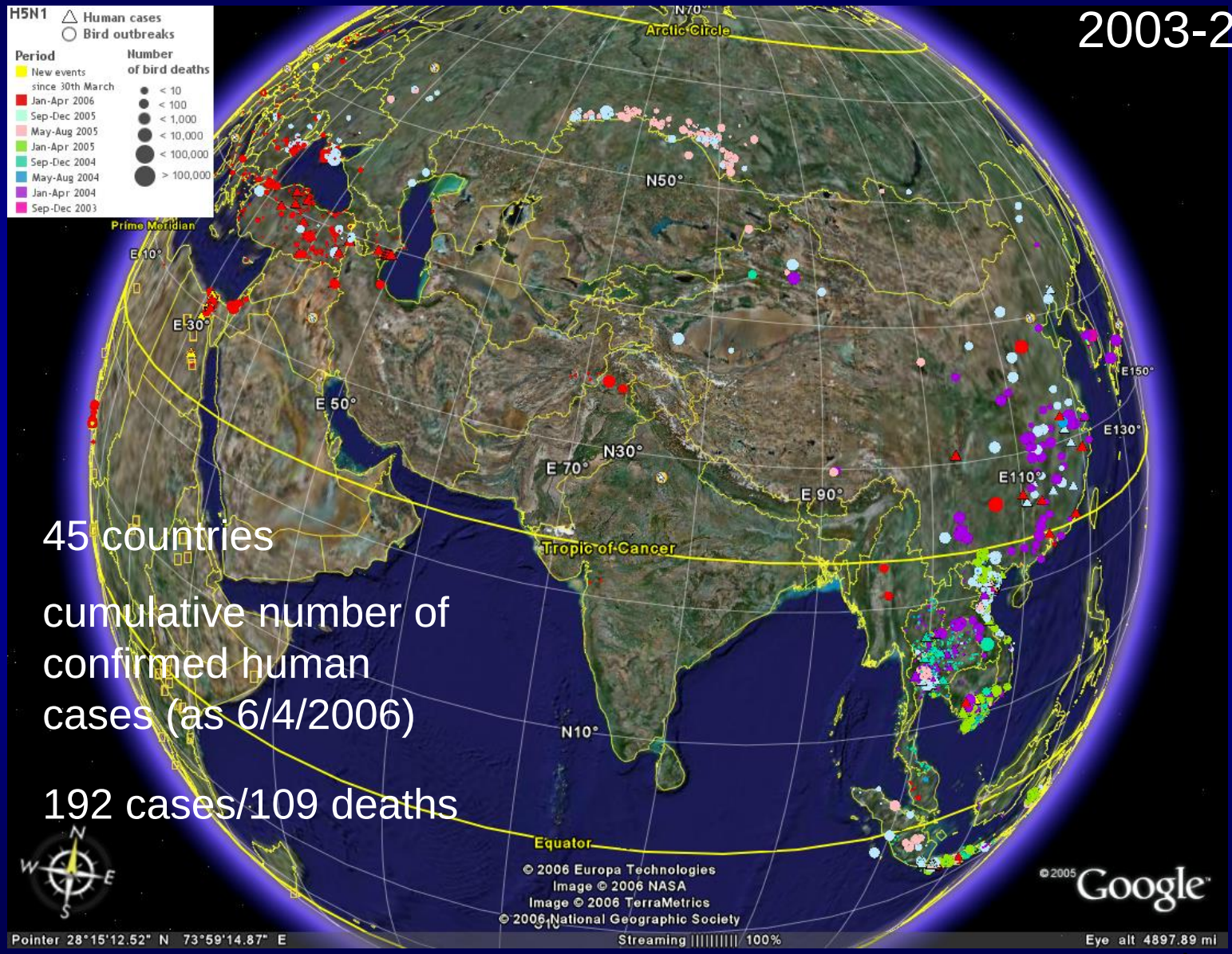
# Global distribution of H5N1 outbreaks




2003-2006

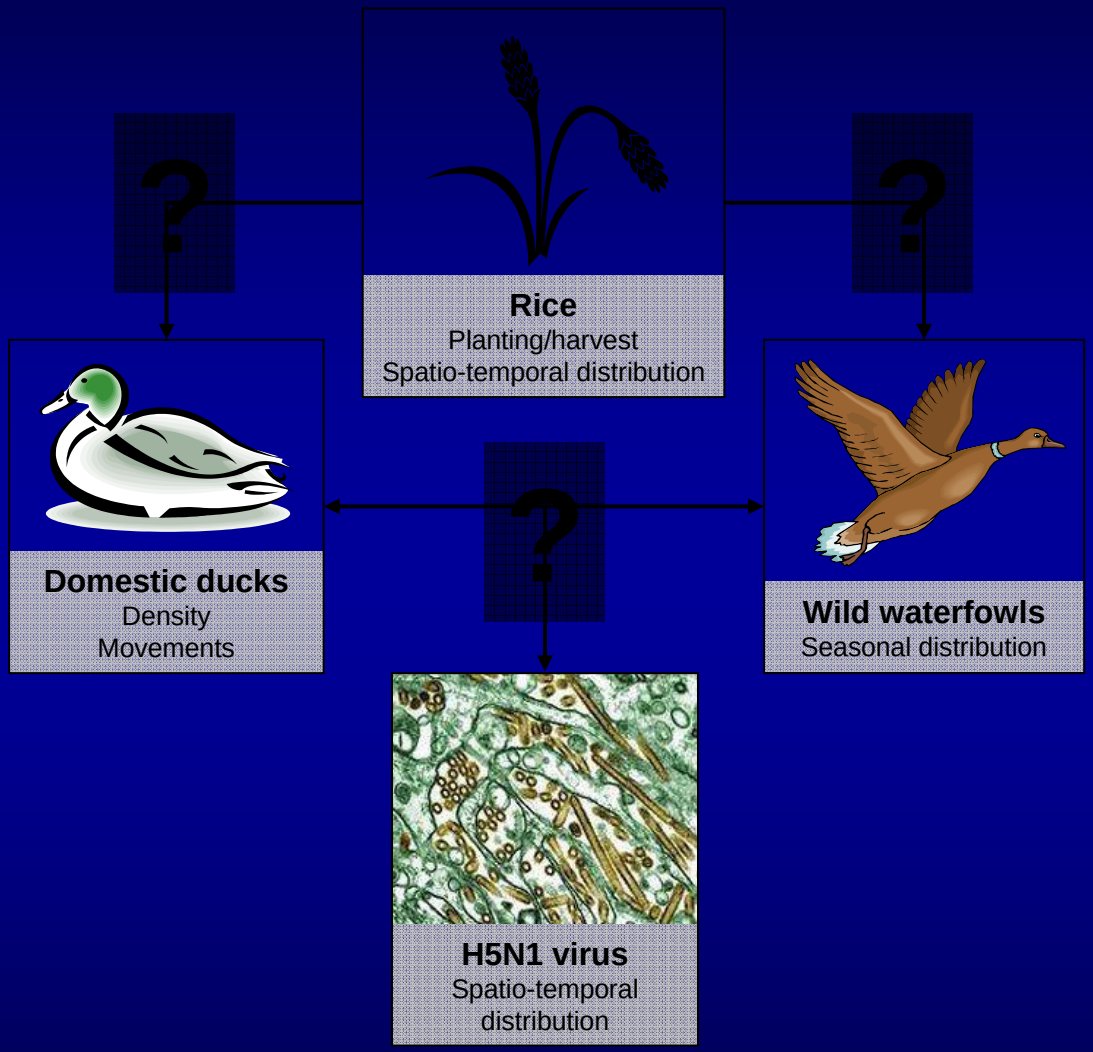
45 countries

cumulative number of confirmed human cases (as 6/4/2006)

192 cases/109 deaths

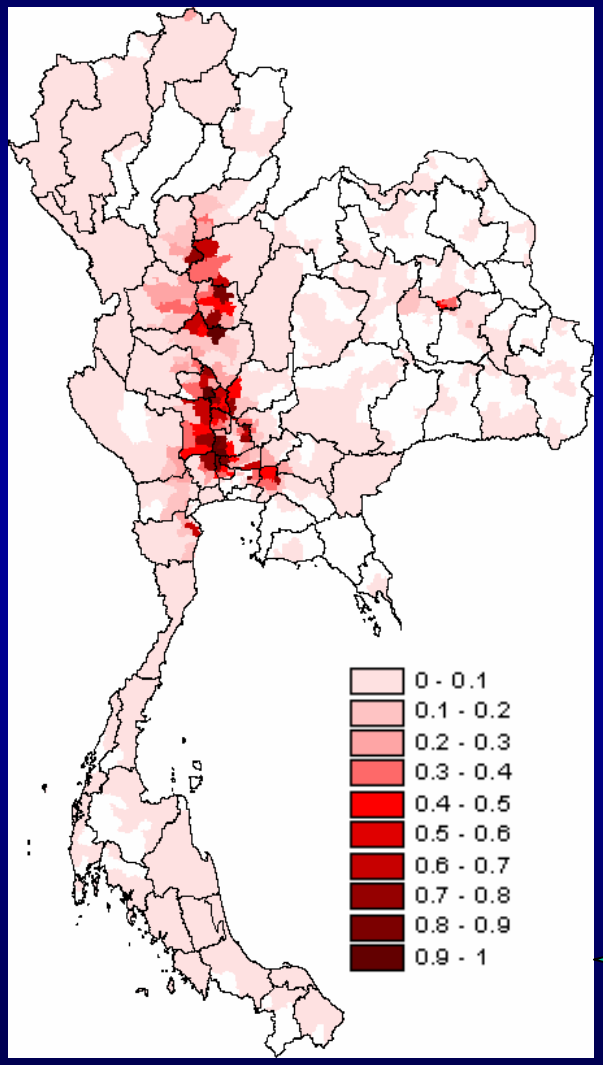
From Declan Butler

# Ecology and Risk Factors of Avian Influenza Virus

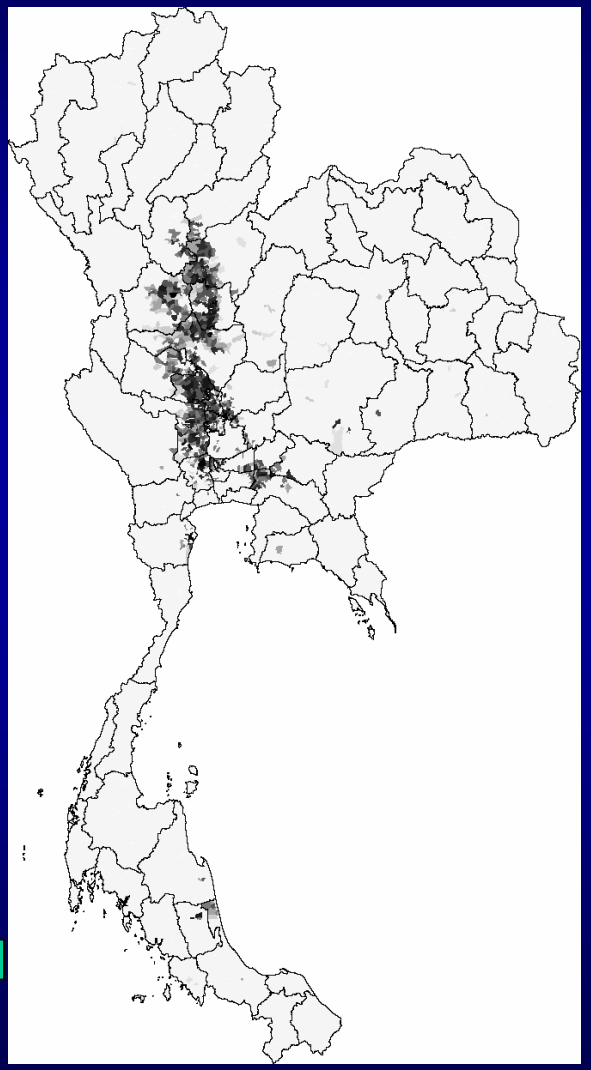



**Interaction of wild waterfowls and domestic poultry in complex and dynamic waterbody (e.g., lakes, fish ponds) – wetland – cropland landscapes**

# Do wild waterfowls use croplands as part of their wintering sites?



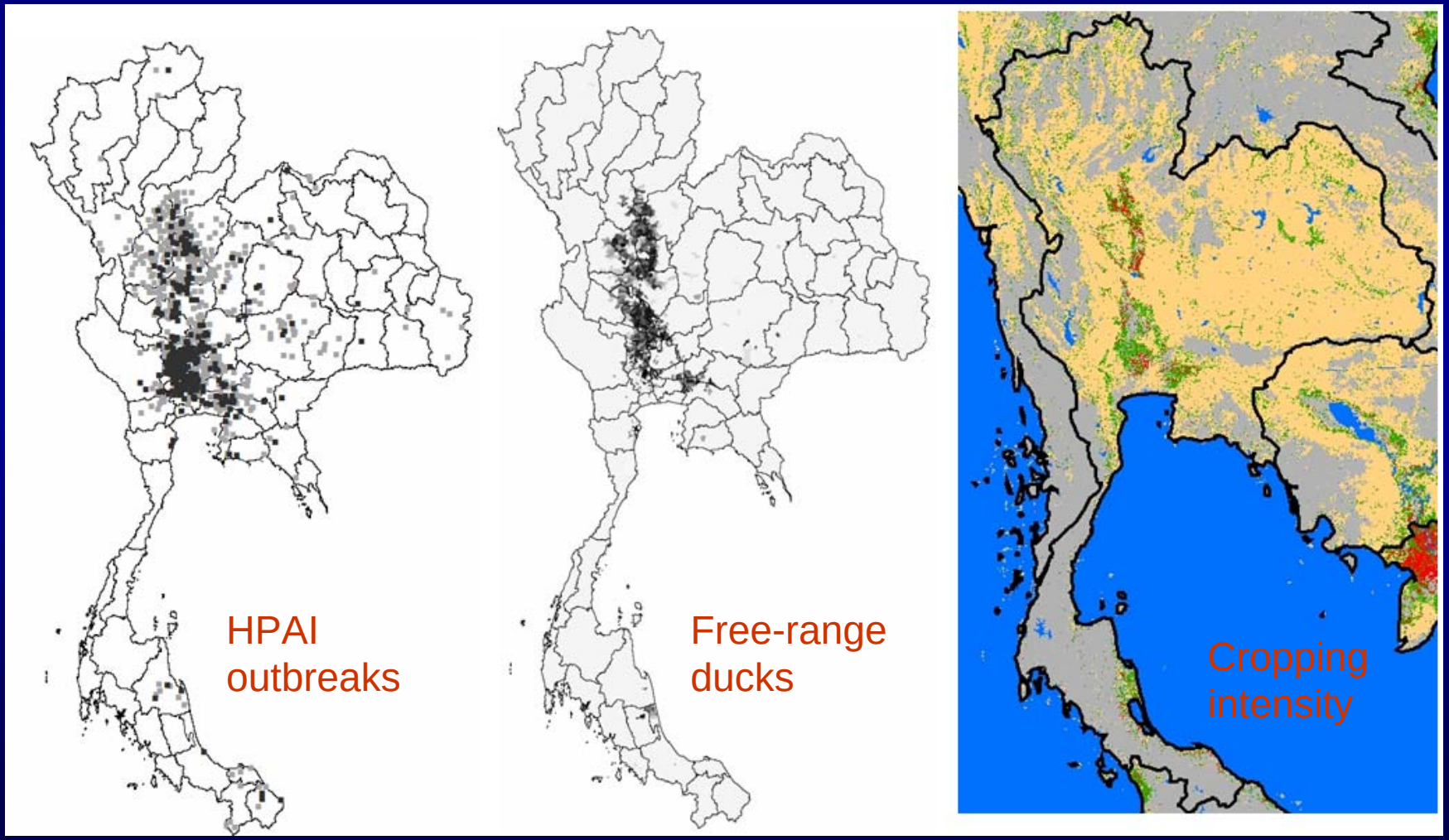

?



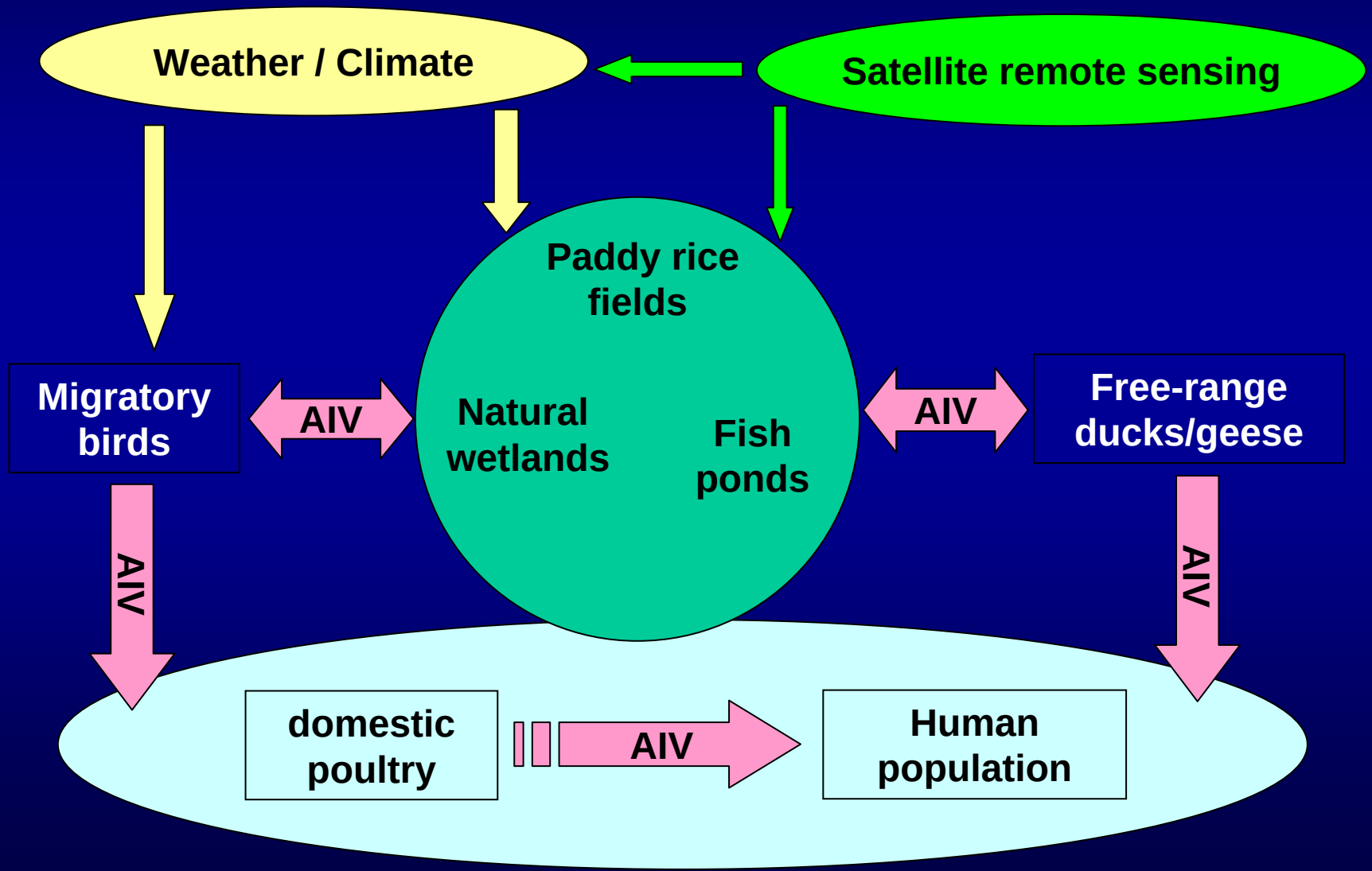
Rice in dry season

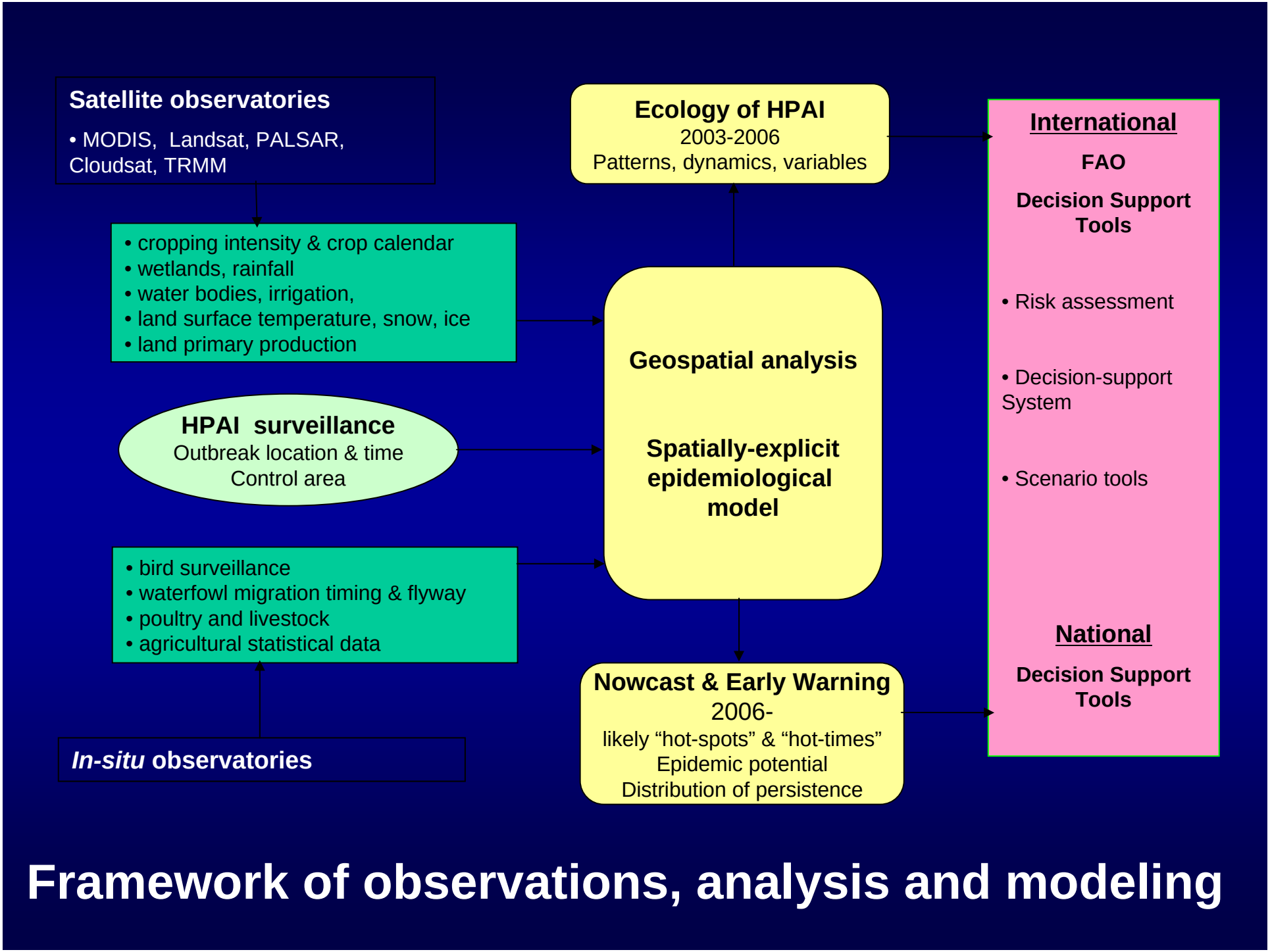
Free-range ducks

# A comparison of spatial patterns among HPAI outbreaks, free-range ducks, and MODIS-derived cropping intensity



# Earth observations, ecology and risk factors of HPAI

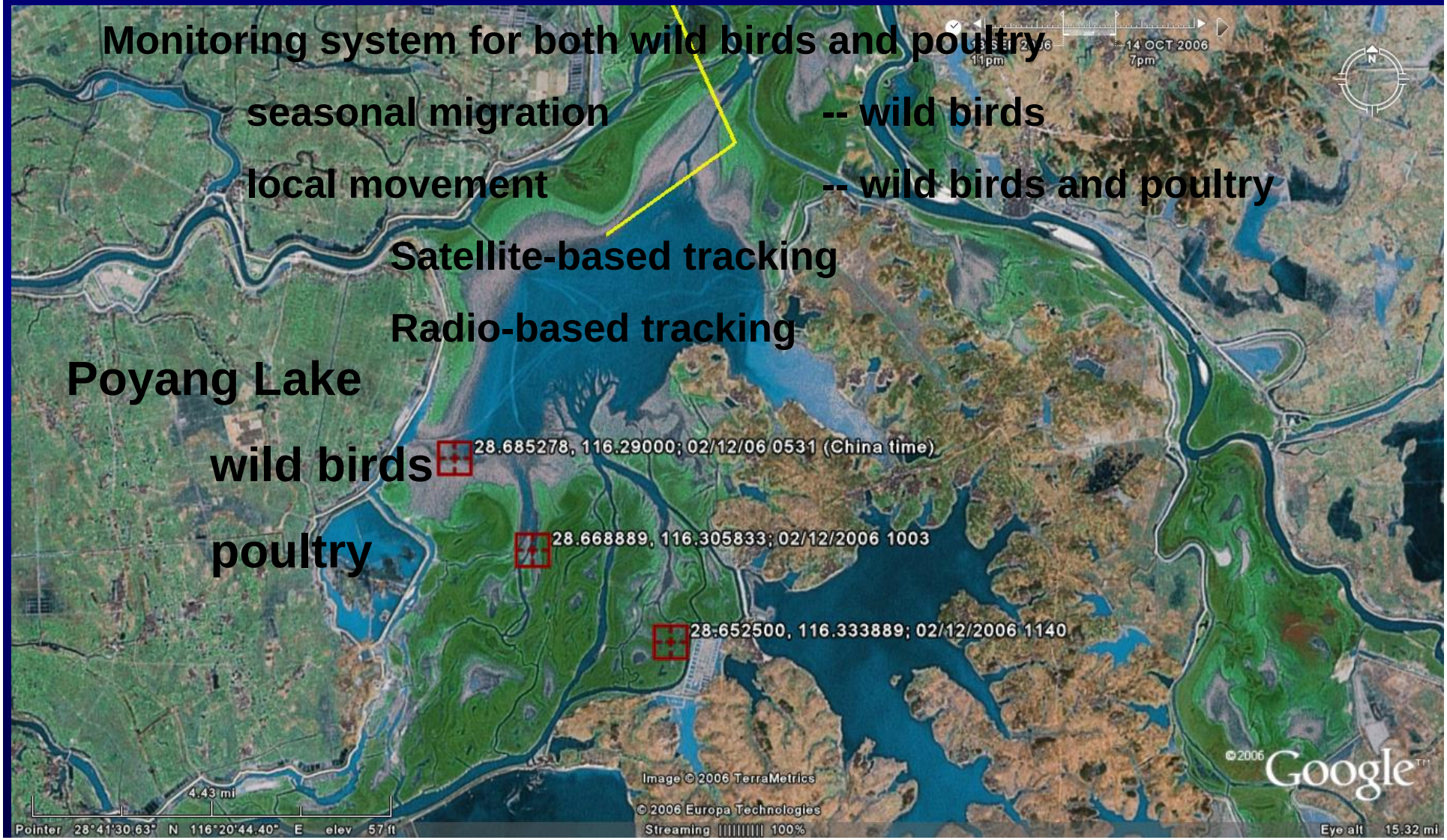




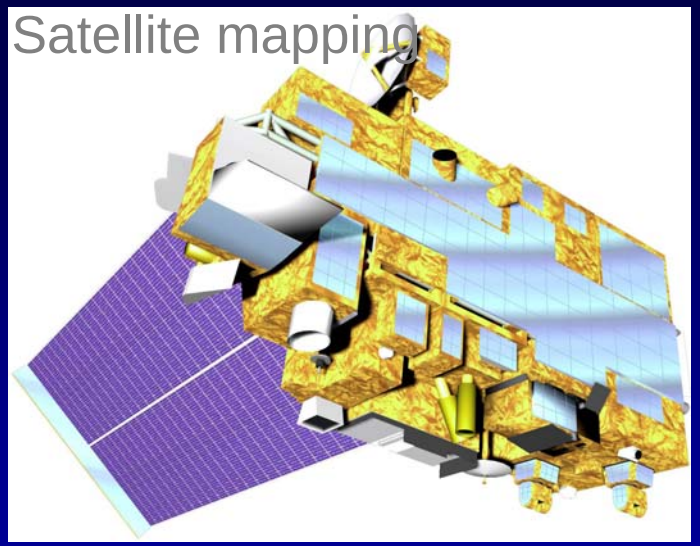

# Framework of observations, analysis and modeling

# PALSAR Demonstration Site: Poyang Lake, China

## Integrated surveillance, monitoring and analysis




H5N1 outbreaks
AFP


Satellite mapping


Free-ranging duck


Paddy rice field