

# The Utility of Remote Sensing for Epidemics and Epizootics

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**AGR-598 Remote Sensing Seminar**

**(Instructor: Prof. Chris Johannsen)**

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# Regional Climatic Vulnerability

- African Sahel Region
  - Endemic Diseases
  - Drought, Famine & Food Insecurity
- Caribbean – Sea Level Rise & Land Loss
  - Urban Coastal Communities
  - Beachfront Tourism v. Eco-Tourism
- USA – Hurricane Frequency & Storm Water Intrusion
  - Gulf of Mexico Coastal Areas
    - » Louisiana
    - » Mississippi

- Downing – Oxford Environmental Change Unit
- Food Security
- Malnutrition & Infection
  - Scrimshaw, Gordon & Taylor
- Basic Human Needs
- Economic Marginality
- Regional Impact of Climate Change Studies

# Development: Myth & Reality

- Mythology of Minority Set Asides
  - Richmond v. J.A. Croson & Co.
  - Sewerage & Water Board Case Study
- Mythology of the Level Playing Field
- Mythology of Trickle Down Theory
- Mythology of Intermediate Technology
- Mythology of Foreign Direct Investment
- Mythology of Benign Dictatorship

# Detecting Vector Habitat Using Remote Sensing:

- *Glossina morsitans*; *G. pallidipes*- (Trypanosomiasis) AVHRR & Landsat TM-Kenya (Allsop)
- *Bulinus Truncatus*; *Biomphylaria pfeifferi* ; *B. smithi*; *B. alexandrina*: (Schistosomiasis)- Blue Nile Health Project (Exogenous Control Research)
- *Schistocerca gregaria*- (Desert Locust) AVHRR-Africa (UN FAO ARTEMIS)
- *Cyclops*- (Dracunculiasis) Landsat TM- Nigeria & Benin (Allsop)
- *Ixodes scapularis* (Deer Tick)- (Lyme Disease) Landsat TM- USA
- *Anopheles albimanus* – (Malaria-*Plasmodium falciparum*) SPOT– Belize (Beck, Lobitz & Wood)
- *Anopheles gambiae* – Landsat TM (Malaria) – Mexico
- *Culex pipiens*, *C. restuans* (predominantly bird-feeding species), *C. salinarius*, *Aedes vexans*, and *Ochlerotatus trivittatus*- (West Nile Virus) Potential applications for ENVISAT, ADEOS II, MODIS Terra, MOMS-2P, Priroda Mir MSU-K, Resurs (Beck, et al.; Robinson, et al.; Rogers, et al.)

# Review Articles

- Goetz, SJ; Prince, SD & Small, J. “Advances in Satellite Remote Sensing of Environmental Variables for Epidemiological Applications,” *Advances in Parasitology*, Vol. 47, 2000, pp.289-307.
- Beck, LR; BM Lobitz and BL Wood. “Remote Sensing and Human Health: New Sensors and New Opportunities,” *Emerging Infectious Diseases*. Vol. 6, No. 3, May-June, 2000, pp. 217-226.
- Rochon, Hildred S.; Amber Randall, Deirdre Brekken & Marilyn Parsons. “Combination of Laboratory Research & Remote Sensing Applications toward Mitigation of Trypanosomiasis in Africa,” IEEE IGARSS 2002, Toronto, Canada, June 24-28.
- Hay, Simon, S. Randolph & D. Rogers. *Remote Sensing & GIS in Epidemiology*. San Diego: Academic Press, 2000.
- Washino, RK and BL Wood. “Application of Remote Sensing to Vector Arthropod Surveillance and Control,” *American Journal of Tropical Medicine and Hygiene*. 2002.

# Epidemiologically-Relevant Environmental Variables:

- Precipitation/Cold Cloud Duration (CCD)
- Vegetation Cover and Type- Spatial/Temporal Dynamics
- Land Surface Temperature (LST)
- Air Temperature
- Atmospheric & Near Surface Humidity
- Surface Wetness & Soil Moisture

# Detecting Vector Habitat Using Remote Sensing:

- *Simulium damnosum* – black fly:  
(onchocerciasis)
- *Phlebotomus papatasi*, *P. perniciosus*, *P. mascittii*, *P. argentipes* – Sand fly:  
(leishmaniasis)
- *Culex*, spp. (Rift Valley Fever)-Synthetic Aperture Radar (SAR) & Landsat TM-Kenya



# Trypanosomiasis

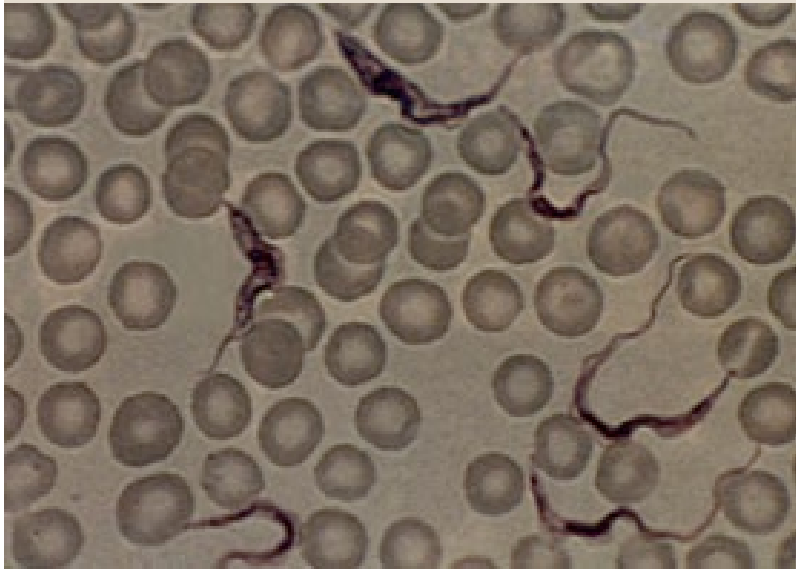
- Protozoan parasite: *Trypanosoma brucei*
- Vector: Tsetse Fly (*Glossina morsitans*)
- Humans – “African Sleeping Sickness”
  - 300,000 infected; 500,000 in high risk areas
- Animals – “Nagana”
- 1<sup>st</sup> stage symptoms as parasite multiplies in the lymphatic and blood systems : swelling of lymph nodes, headaches, fever, muscle & joint pain,
- 2<sup>nd</sup> stage, as parasite invades the central nervous system: neurological disorders, slurred speech, behavioral changes, loss of motor control, extreme lethargy during daytime and insomnia at night.
- Advanced Stages: *T. brucei rhodesiense* (East Africa): coma and death within weeks of initial infection; *T. brucei gambiense* (West Africa): usually fatal within months to a few years after initial exposure
- Control: trypanocides applied to tsetse habitat; Biogenic control mechanisms

# Trypanosomiasis

- Tsetse fly (Bantu Name)  
*Glossina morsitans*
- *Trypanosoma brucei*

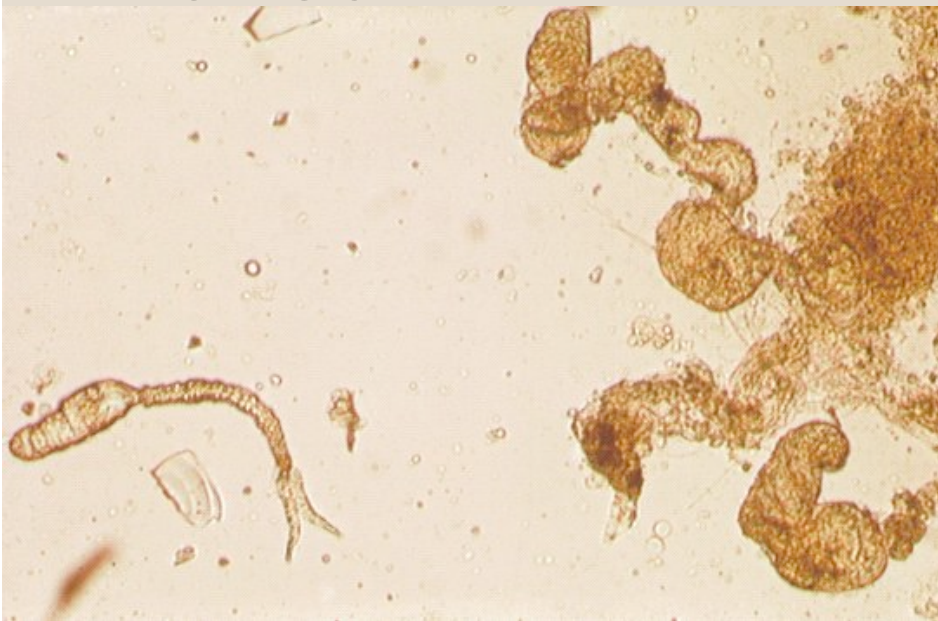


Rogers, DJ & S. Randolph. "Monitoring Trypanosomiasis in Space & Time." *Parasitology*. 1993; 351:739-741.



# Schistosomiasis

- Biomphylaria >>>>>
- Schistosoma mansoni



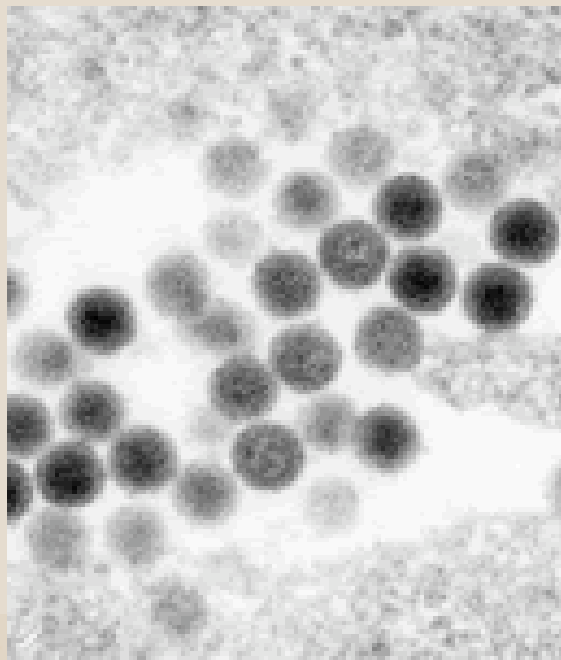
# Leishmaniasis

- Phlebotomus paptasi>>>
- Leishmania



# Rift Valley Fever

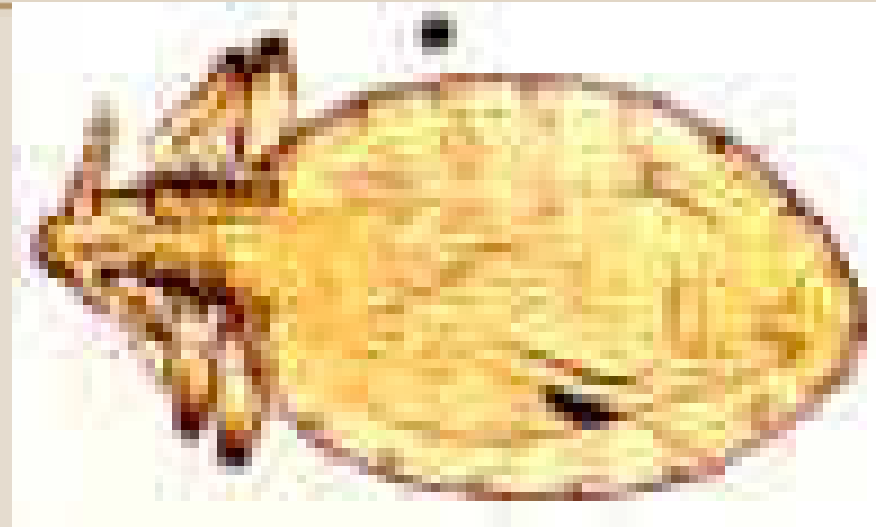
- *Culex pipiens* & *Aedes*
- RVF Virus



**Linthicum, KJ, et al. (1999) Climate & Satellite indicators to forecast Rift Valley Fever epidemics in Kenya. *Science* 285, 397-4000.**

# Brucellosis

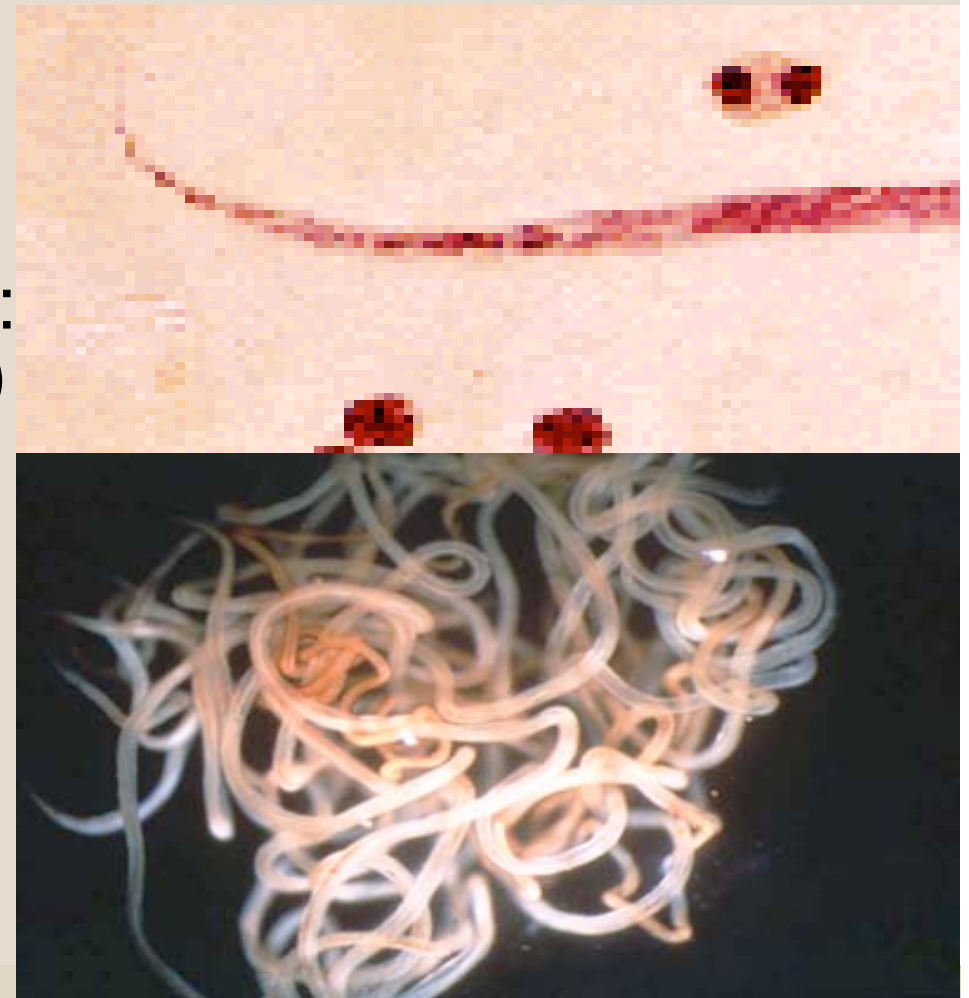
- Brucella>>>>>
- “contagious abortion” or Bang's disease.
- In humans, “undulant fever” or “Malta fever”
- Main threat is to cattle, bison, and swine; but also goats, horses, sheep and dogs



# Onchocerciasis

- Merck & Co. donate Ivermectin, since Oct.'87 to treat onchocerciasis (150 mg/kg single dose) for microfilaria. Alternative: diethylcarbamazine (DEC) & Suramin (macrofilia)
- Temephos & clorphoxim insecticides resistance
- Adult worms life expectancy: 10-15 years

*Onchocerca volvulus*



# River Blindness

- 27 species of onchocerca affecting animals other than humans (Alfons Renz)





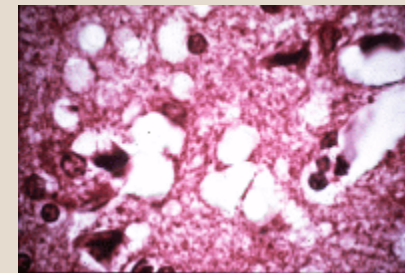
# Simulian damnosum: Black Fly

- Subcutaneous Nodules
- Microfilarial lesions



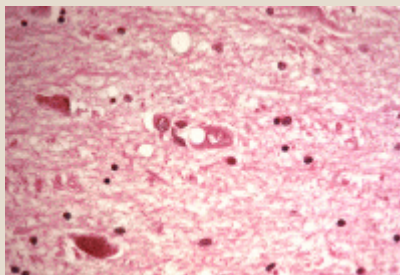
# Mad Cow

- **mad cow disease**  
(bovine spongiform encephalopathy or BSE)

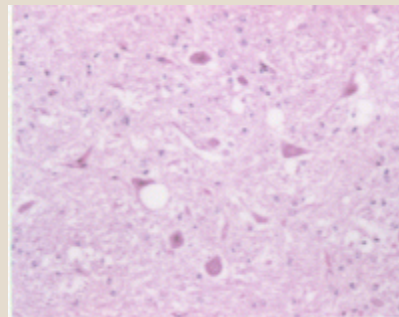


Kuru - human

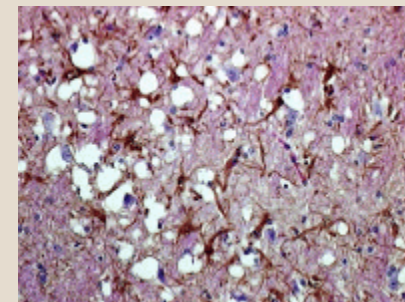
CJD - human



Creutzfeldt-Jakob disease



BSE - (cow)



Scrapie - (sheep)

# Heartwater (Cowdriosis)

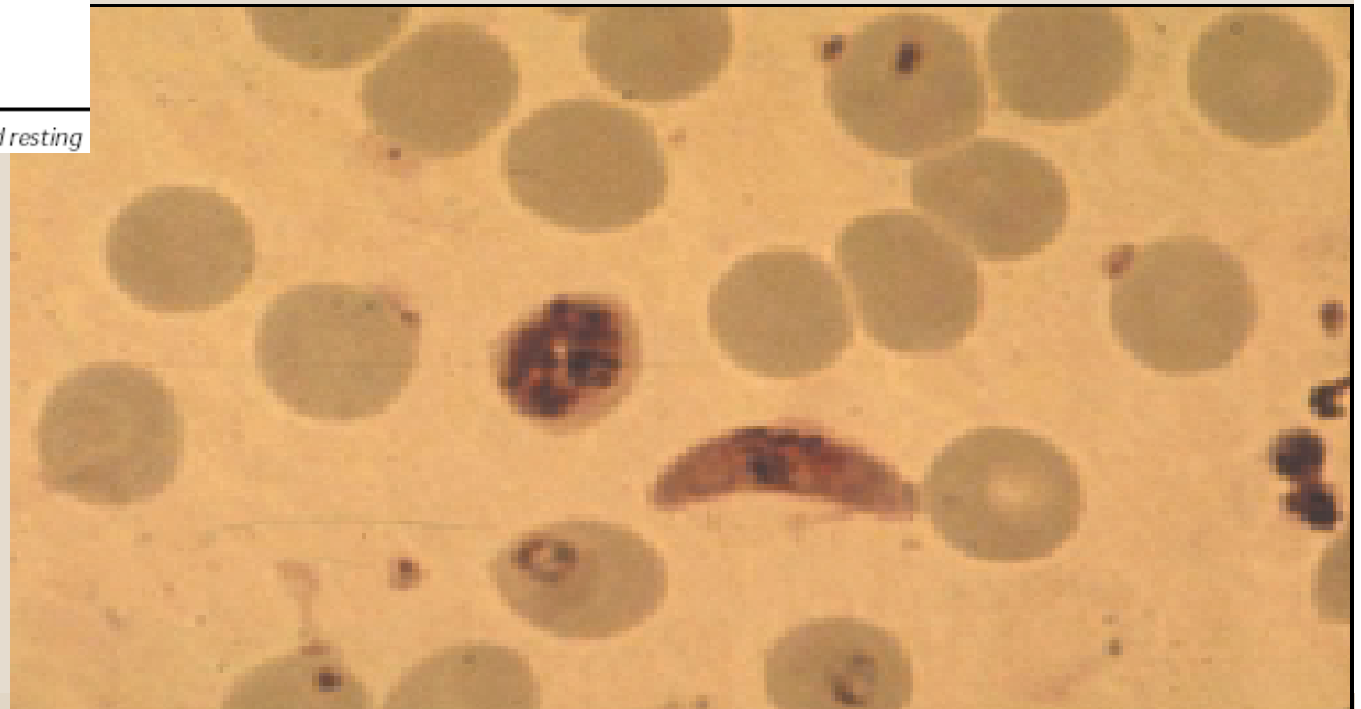
- *Cowdria ruminantium* transmitted by ticks:  
*Amblyomma*
- *Symptoms: fever,*  
hydropericardium,  
edema of lungs  
high mortality



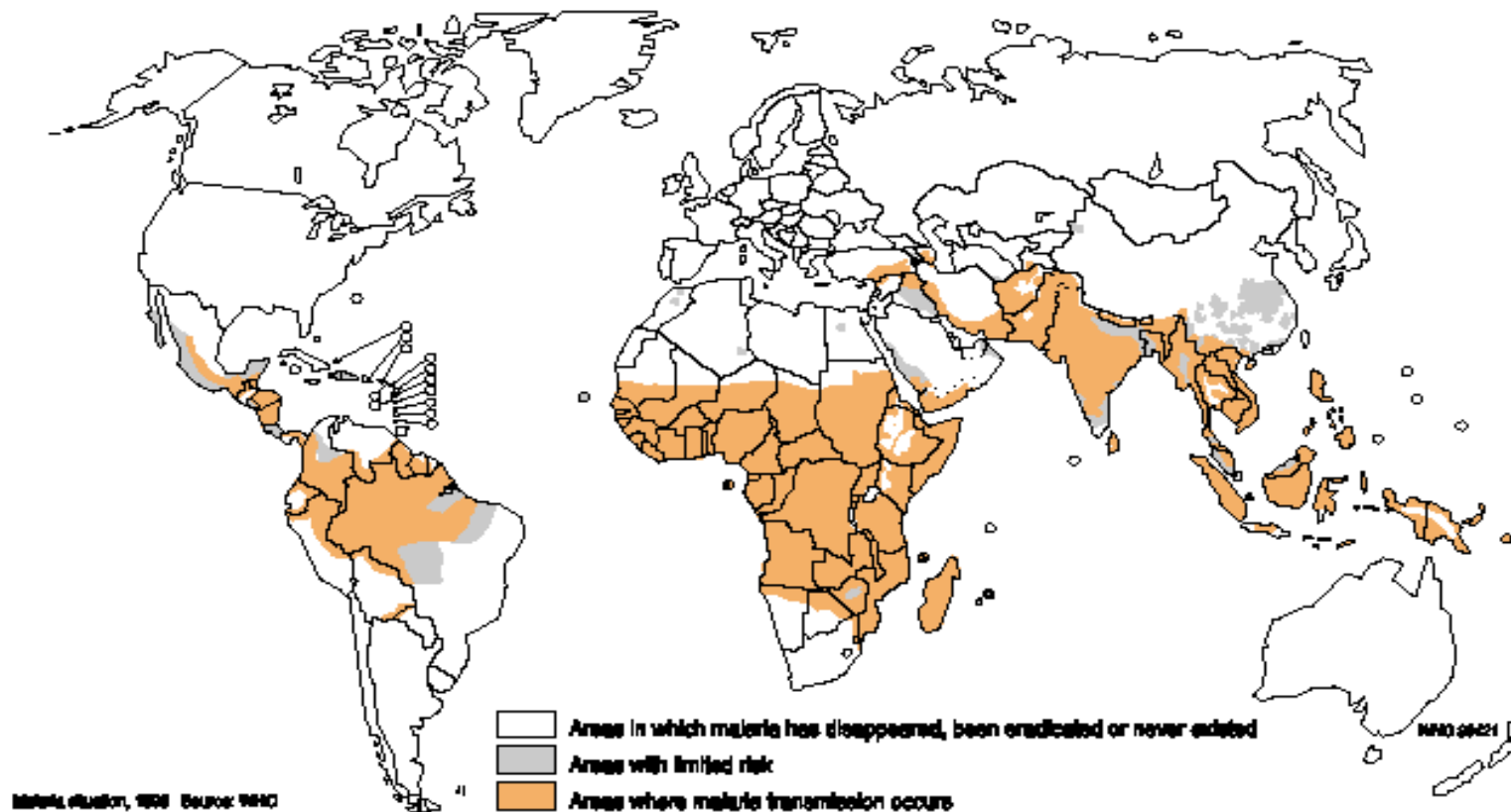
# Plasmodium Falciparum: Female Anopheles Mosquito



*Above: Anopheles mosquito in characteristic biting and resting*



# Malaria



Above: World malaria situation. Malaria is endemic to tropical and subtropical regions.

# Malaria



*A child with malaria. Malaria kills an African child every 30 seconds.*

# Protein Energy Malnutrition (PEM)

- Kwashiorkor
- Marasmus
- Synergistic Relationship: Malnutrition & Infection (Scrimshaw, Gordon & Taylor)

- Irrigation problems in field in Nebraska (ADS –Airborne Data Systems)

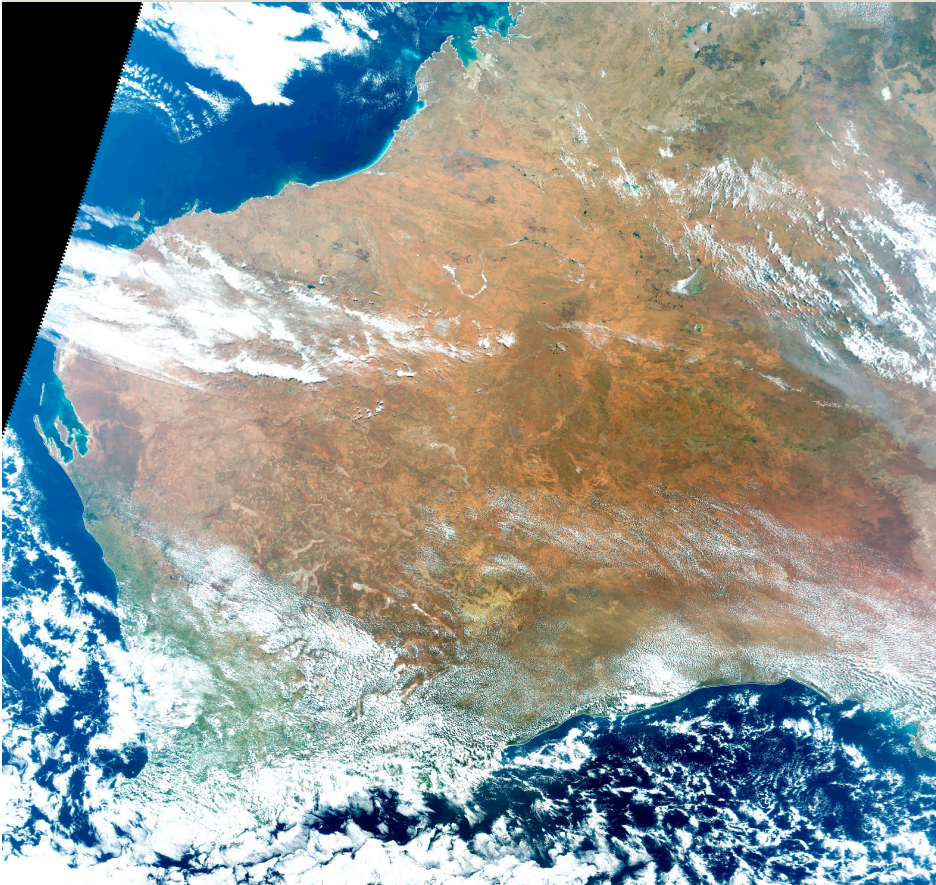




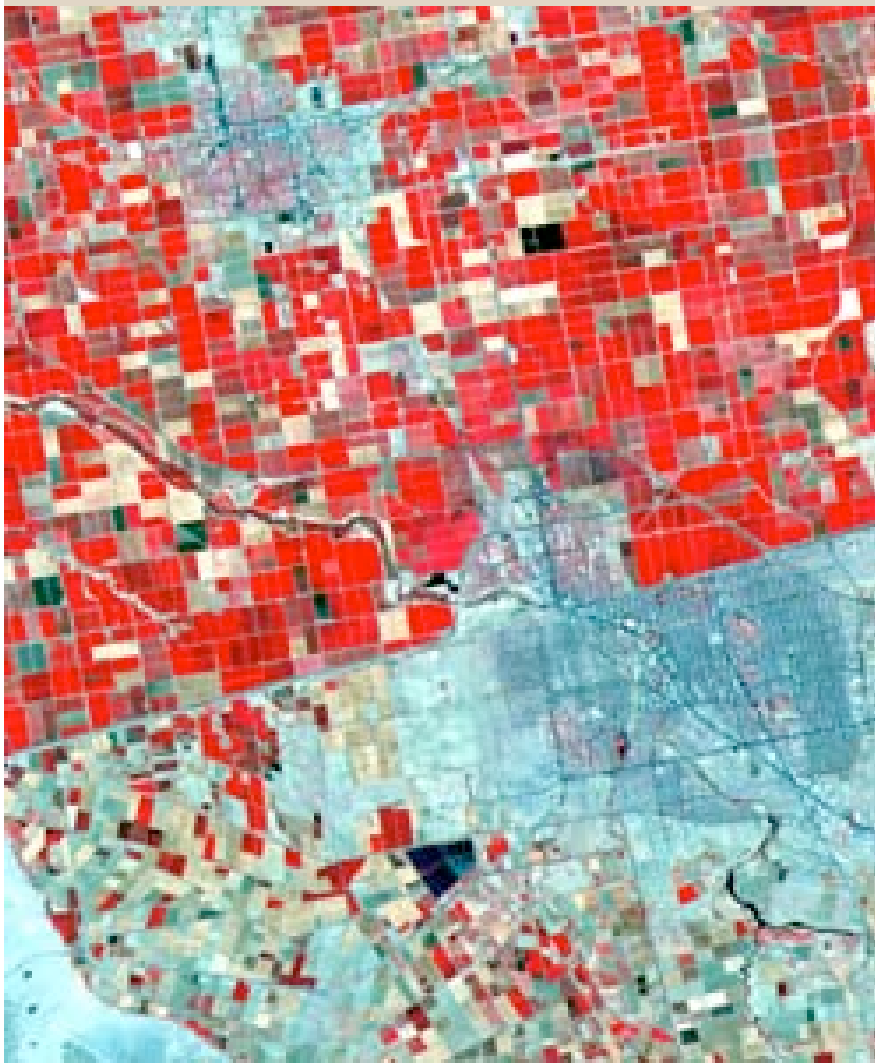
# Agricultural Insect Infestation



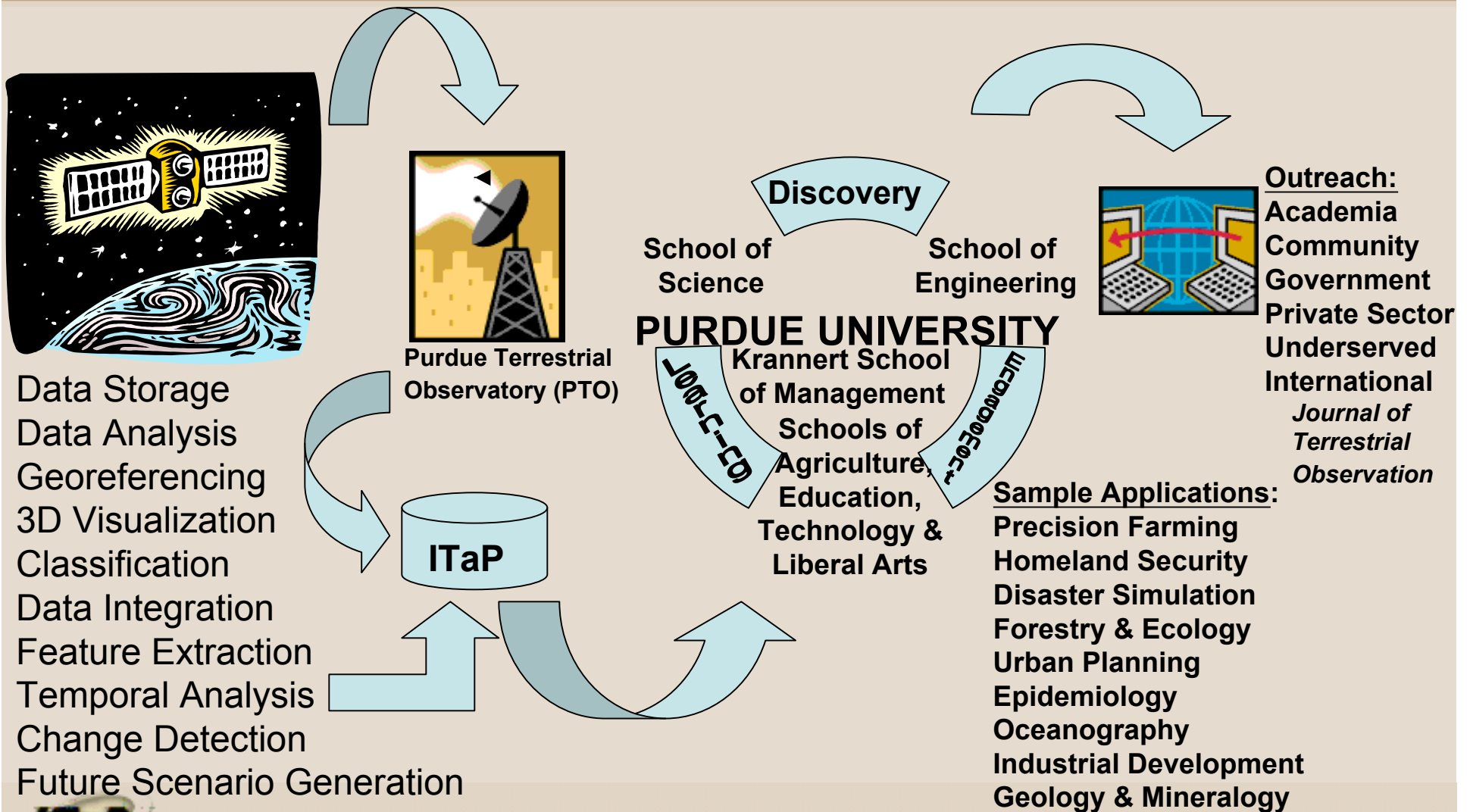
# Need for Course Resolution & High Resolution Data:



# Need for Course Resolution & High Resolution Data:



# PTO - Data Flow:



# PTO: Stages II-IV

- Redundant Receiving Stations
- Sensor Diversity
- Real-Time-Ready Classroom
- 3D Virtual Globe Mapparium
- Permanent Research Facility
  - LARS, CAAGIS, Geomatics, ICP/AA/XRF
  - Enhanced Ground Truthing Capability
- Endowed Chair/Director & Student Fellowships

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