Location-based Epidemiology: The new Frontier

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From Location to Informative Pixels

Location
Prediction
Identification

Dr. John Snow's Original Cholera Cases in London Map, 1854
Invasion map of *Anopheles gambiae* s.l. in Brazil. Predicted ranges of *A. gambiae* and *A. arabiensis* developed from the native range models (Figure 1) and projected onto climate data from 1931 to 1960 for South America (Levine et al., 2004 ASTMH 70:105–09). Operational Map used during the Malaria and Yellow Fever *Aedes aegypti* Eradication Campaigns.
Location of mosquito oviposition sites along the Sangamon River in Central Illinois, 1974-75.


THE IMPORTANCE OF PIXEL DIMENSIONS
Evolution of satellite sensor resolution

Landsat 30m data
Landsat ETM + 15m data
Mutispectral Thermal Imager at 5m
SPOT at 2.5m data
IKONOS at 1 m data
QuickBird at 0.61 m

WEST NILE VIRUS

Progression of West Nile Virus Epidemic by Location and Time, 2002
Effect of birds on the transmission dynamics of WNV

Landscape
Why does WNV activity peak in late summer?
- mosquitoes
- weather
- birds

Assistance from MADs

Radio-Tracking and Mapping Crow Movement

WHY ??
- First sign of WNV activity
- Importance in the zoonotic cycle??

Crow Roost locations in Champaign and GIS Radio Tracking
Kriging is a geostatistical technique to predict the values of a random field at an unobserved location from sampled observations at nearby locations.

Distribution of risk exposure of West Nile virus in Chicago

Application of High Resolution Imagery and GIS for Epidemiological Studies
Informative Pixel

QuickBird at 0.6 meter per pixel
WorldView at 0.2 meter pixel

QuickBird 0.61m image of the Kangichiri, Mwea Rice Scheme, Kenya

Operational Map used during the Eradication Campaigns 1950-1962 versus 2010 QuickBird Satellite Image with 0.6 Meter resolution.
Multiple Drug Resistant TB

San Juan de Lurigancho Peru Valley and Prison
Location of Health Clinics San Juan de Lurigancho, Peru.

Geographical clusters of MDR-TB in San Juan de Lurigancho, Peru associated with a Prison.

Environmental Variables that may Effect MDR-TB Transmission

- Prison
- Urban Land Cover
- Vegetation
- Hydrology
Simulation Model of MDR-TB transmission overlaid on Location-based QuickBird data.

Intensity of multidrug resistance of larvae-estimation

(red=cases, black=controls)

0
20000
40000
60000
80000

Simulation Model of MDR-TB transmission overlaid on Location-based QuickBird data.

The Pixel

QuickBird at 0.6 meter per pixel
WorldView at 0.2 meter pixel

Ground control coordinates of Simulium damnosum s.l. breeding sites on Landsat data with a 25 km buffer around each collection site.
GIS polygon of Precambrian rock and associated hydrological attribute data associated *S. damnosum*.

Remote masking of *S. damnosum* s.l. habitat with Precambrian rock.
Spectral signature of the *S. damnsoum* s.l. habitat and Precambrian rock polygon at the Dienkoo study site

The *S. damnsoum* s.l. habitat and Precambrian rock pixel in terms of endmember spectral composition (i.e., red, green, blue)

Tire signatures with predicted site in Alabama
Waste tire site in Jefferson County, Alabama

Backyard Swimming Pools Los Angeles County California.

Band Data from Other Satellites used with QuickBird & WorldView.
**Public Health Information Systems**

PHDIS: a Portal to actionable insight

Integrated Malaria Surveillance System