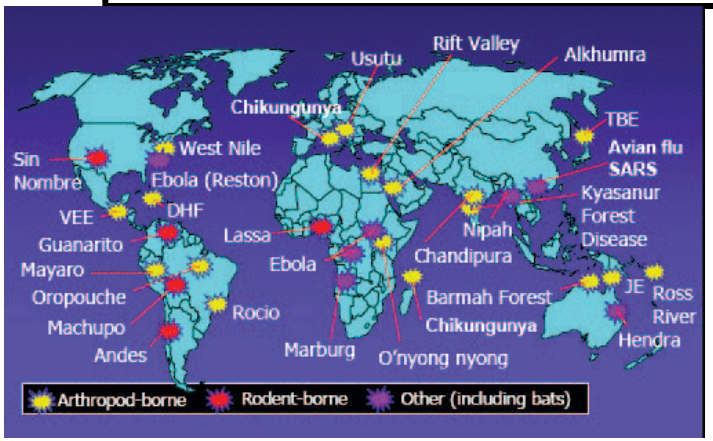
CQ6. Human Health and Urbanization

How do patterns of human environmental and infectious diseases respond to leading environmental changes, particularly to urban growth and change and the associated impacts of urbanization?

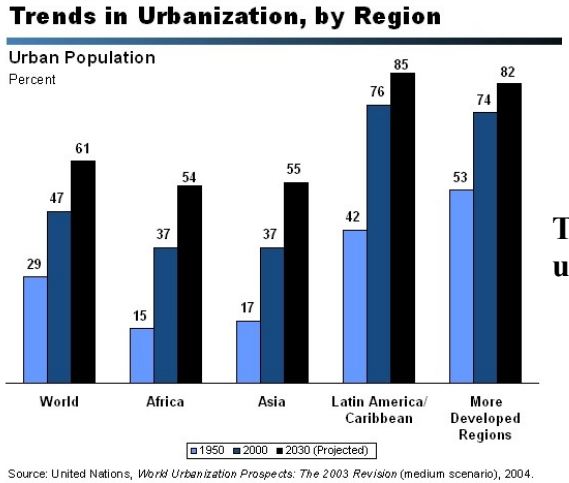
CQ6: Sub-Questions

- **How do land surface characteristics such as vegetation state, temperature, and land cover composition affect, and are affected by, heat stress and drought, and vector-borne and zoonotic diseases?**
- **What changes can be observed and measured in emissivities of urban surfaces and how do emissivities change for different cities around the world as they impact the urban heat island and associated land-atmosphere energy balance characteristics?**
- **How does the distribution of urban and peri-urban impervious surfaces affect regional energy balance fluxes, hydrologic processes, and biogeochemical fluxes, and what is the response of ecosystems to these changes?**

CQ6: How do patterns of human environmental and infectious diseases respond to leading environmental changes, particularly to urban growth and change and the associated impacts of urbanization?



Presence or emergence of specific diseases around the world.



Source: United Nations, *World Urbanization Prospects: The 2003 Revision* (medium scenario), 2004.

Trends in global urbanization

Satellite image of urbanization in the Shenzhen, China region

Science Issue:

•The world is rapidly urbanizing and it is anticipated that by 2025, approximately 70% of the world's population will live in cities. It is also projected there will be over 100 "megacities" in the world by 2025, those cities with 10 million population or greater. Urbanization has a profound impact on the environment, and as cities grow, there are a host of other impacts including a potential increase in insect- and animal-borne diseases. Because of its high spatial resolution and hyperspectral/multispectral characteristics, HyspIRI data will be able to provide more detailed data that can be used to better and model land surface characteristics and their impacts on disease vector prevalence, persistence, and spread.

Tools:

•Combined observations from satellite visible and thermal IR bands to observe and measure urbanization around the world

•Assessment of land cover characteristics or vegetation state that propagates vector or animal disease carriers

Approach:

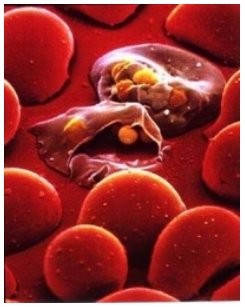
•Use HyspIRI hyperspectral VSIR/VNIR data to characterize global urbanization and impacts on the environment, such as forest

• Use HyspIRI multi-temporal thermal IR data in conjunction with VSWIR/ VNIR data to evaluate landscape state, extent and condition as a measure of assessing prevalence of vector or animal disease carriers.

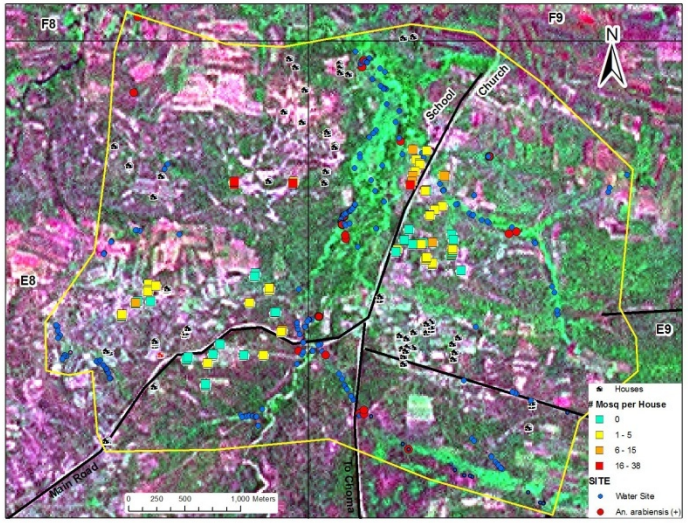
Results:

Urban growth and change can be readily identified from remote sensing data. HyspIRI with its improved hyperspectral and multispectral capabilities will greatly increase our ability to monitor the impacts of urbanization on the environment and assess land cover characteristics that potentially indicate the risk or presence of vector- and animal-borne diseases on a global scale.

CQ6a: How do land surface characteristics such as vegetation state, soil moisture, temperature, and land cover composition affect heat and drought, and vector- and animal-borne diseases? (DS 156, 158, 160, 183-184, 198)



Vectors, such as mosquitoes transmit many deadly parasitic diseases such as malaria. Combinations of visible and IR bands are associated with areas where there are elevated likelihood of mosquitoes allowing targeted intervention and treatment.



MODIS image showing land cover with numbers of mosquitoes per house to indicate risk of malaria

Science Issue:

•Land surface characteristics greatly influence the factors affecting vector- and animal-borne diseases. Because of its high spatial resolution and hyperspectral/multispectral characteristics, HyspIRI data will be able to provide more detailed data that can be used to better and model land surface characteristics and their impacts on disease vector prevalence, persistence, and spread.

Tools:

•Combined observations from satellite visible and thermal IR bands to define areas of potential likelihood of vector- or animal-borne disease incidences globally

•VSWIR and VNIR data are particularly important for assessment of land cover characteristics or vegetation state that propagates vector or animal disease carriers

•Thermal IR data are most important for measuring surface temperature and emissivity to augment interpretation of VSWIR/VNIR data

•*In situ* measurements for assessment of presence and number of vector or animal disease carriers

Approach:

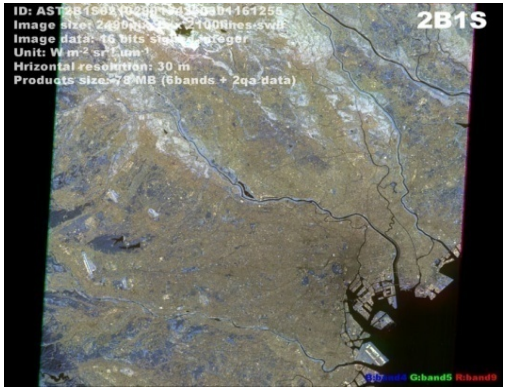
•Use HyspIRI hyperspectral VSIR/VNIR data to characterize landscape and vegetation state, extent, and condition as a measure of assessing prevalence of vector or animal disease carriers

• Use HyspIRI multi-temporal thermal IR data in conjunction with VSWIR/ VNIR data to evaluate presence of water bodies and surface temperature conditions to support disease carriers.

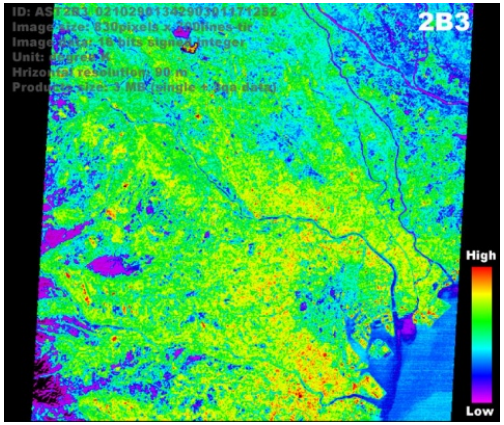
Results:

Remote sensing data have shown good promise in applications in many aspects of public health, especially risk assessment related to infectious diseases caused by insect and animal pathogens. HyspIRI with its improved hyperspectral and multispectral capabilities will greatly increase our ability to monitor vector- and animal-borne diseases on a global scale.

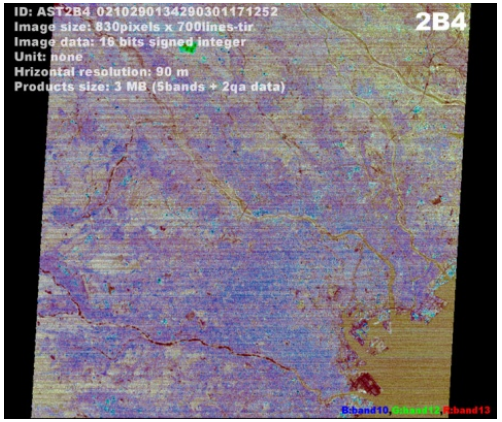
CQ6b: What changes can be observed and measured in emissivities of urban surfaces and how do emissivities change for different cities around the world as they impact the urban heat island and associated land-atmosphere energy balance characteristics? (DS 167-168)



ASTER color composite image of Tokyo, Japan



ASTER thermal IR surface temperature image of Tokyo, Japan



Emissivity image of Tokyo, Japan derived from ASTER VSWIR/VNIR and TIR data

Science Issue:

•There are scant measurements of emissivities of specific surfaces for urban areas and how emissivities vary for cities with different urban landscape morphologies and located in different geographic locations around the globe. HyspIRI data with its high spatial resolution and hyperspectral VSWIR/VNIR and multispectral TIR capabilities will be of significant benefit in providing better measurement of global urban emissivities.

Tools:

•VSWIR/VNIR and TIR satellite observations for measurement of urban land cover characteristics brightness and surface temperatures around the globe

•Frequent re-visit cycles to measure variability in land cover brightness and surface temperature parameters

•Seasonal VSWIR/VNIR/TIR data of urban areas around the globe

•Calculation of emissivities for urban surfaces for different cities around the world

Approach:

•Evaluate the emissivity values for "common" or ubiquitous urban surfaces around the globe

•Use HyspIRI high spatial resolution, hyperspectral VSWIR/VNIR and TIR data to measure small-scale variations in urban surfaces through time

•Model development of relationship between emissivities of urban surfaces and dynamics of the UHI for different global cities

Results:

There is little knowledge on how emissivities for urban surfaces vary for different cities in different geographic and climatic regions around the globe. There is also a paucity of knowledge on what the relationship is between emissivity and the development, form, size, and dynamics of the UHI. HyspIRI with its high spatial resolution and hyperspectral and multispectral capabilities will greatly assist in the development of emssivity models for cities around the globe.

CQ6c: How does the distribution of urban and peri-urban impervious surfaces affect regional energy balance fluxes, hydrologic processes, biogeochemical fluxes, and what is the response of ecosystems to these changes? (DS 167-168, 198, 203)

Environmental management strategies at Valles Caldera National Preserve, NM utilizes MODIS imagery for locating study sites for water quality , biogeochemical studies and monitoring wildlife and wetland quality.

Science Issue:

•What impacts does the growth of impervious surfaces associated with urbanization have on hydrologic processes, biogeochemical fluxes, and ecosystems? HyspIRI data will enable us to derive better estimates of global urban impervious surfaces and provide more detailed measurements of what the impacts are on hydrology, biogeochemical fluxes, and ecosystem response.

Tools:

•Satellite VSWIR/VNIR and TIR measurements for measuring energy fluxes and vegetation state/condition for quantification of biogeochemical fluxes in or near urban areas globally

•Satellite observation of lakes, rivers, wetlands, marshlands, and coastal estuaries that are impacted by urbanization currently, or will be impacted by urbanization in the future

•*In Situ* observations to validate measurements from satellite data

•Integration of satellite and *in situ* measurements to model energy fluxes, hydrologic processes, and biogeochemical cycling as affected by urbanization

Approach:

•Evaluate vegetation, surface temperature and hydrologic conditions for critical environmental habitats using HyspIRI hyperspectral VSWIR/VNIR and multispectral TIR data

•Evaluate biogeochemical cycling, energy flux dynamics and hydrologic processes through time and across seasons using HyspIRI multi-temporal data

•Use HyspIRI and *in* situ data to facilitate modeling of hydrologic processes and biogeochemical cycling around cities around the globe as they are impacted by impervious surface expansion

Results:

HyspIRI high spatial resolution, multi-temporal, hyperspectral VSWIR/VNIR and multlspectral TIR data combined with *in situ* data, can be used to derive more in-depth quantitative models of hydrologic processes and biogeochemical cycles for critical habitats.