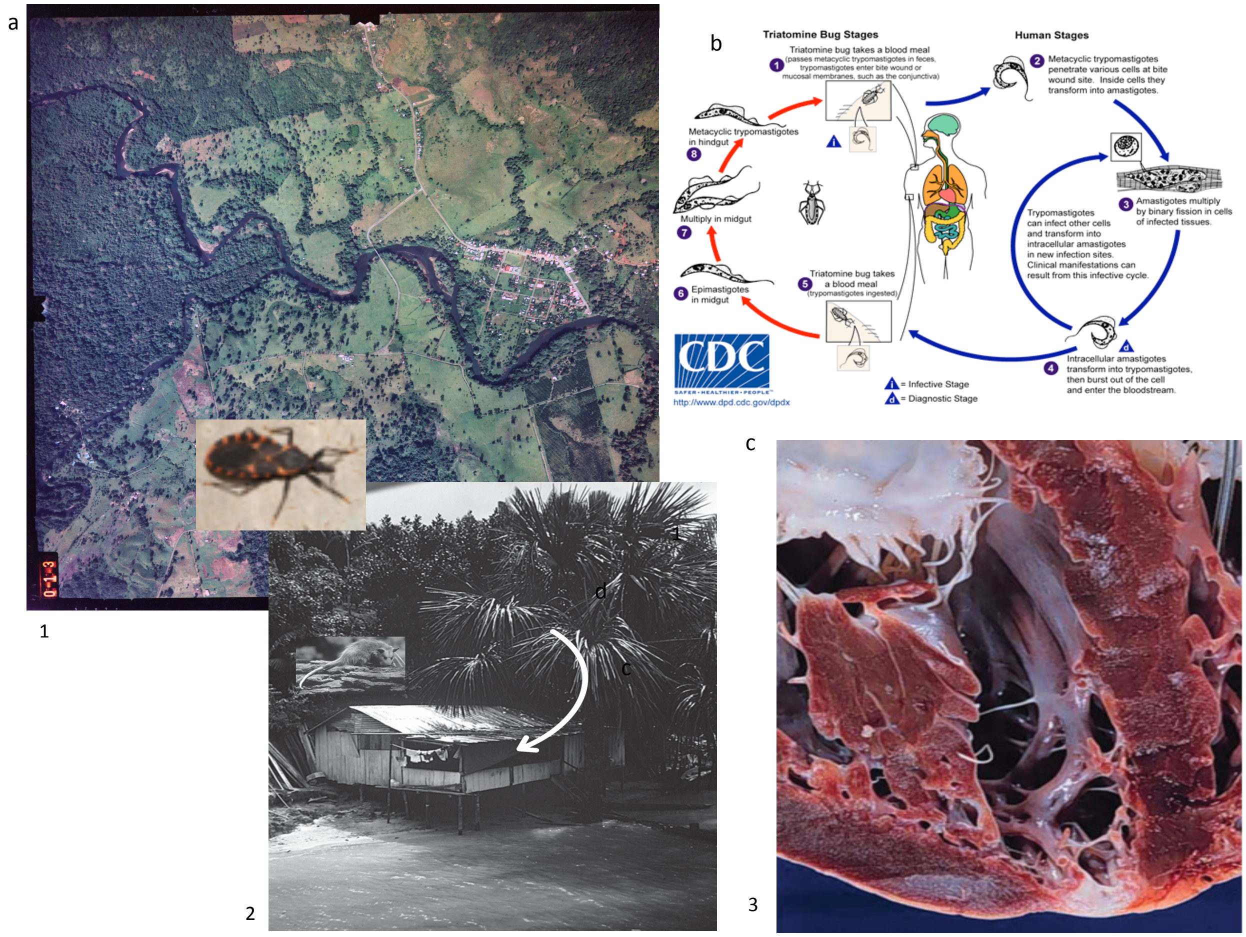
HyspIRI MISSION APPLICATIONS – Public Health



a) Human alteration of the landscape impacts both the habitat and the natural life cycles of many important insect disease vectors. These changes in the landscape result in close human and domesticated animal contact with insects that normally feed on non-human hosts and native wildlife species. Chagas is an example of a significant human protozoan disease (*Trypanosoma cruzi)* that emerged over the last 200-300 yrs after the destruction of its insect vector's natural forest habitat. The natural life cycle of triatomines (Kissing bug), subsequently adapted to domestic environments such as houses and farm buildings, thus bringing the kissing bug into direct contact with humans. b) An infected triatomine insect vector (or "kissing" bug) takes a blood meal and releases trypomastigotes in its feces near the site of the bite wound. Trypomastigotes enter the host through the wound or through intact mucosal membranes. In humans, the acute phase lasts for the first few weeks or months after infection. An infected individual may be symptom-free or exhibit only mild symptoms during that time period. The chronic stage develops over many years and affects the nervous system, digestive system and heart. c) Cardiac damage is severe in later chronic stages.

[1] NASA. [2] Coura, J. R. (2007). "Chagas disease: what is known and what is needed - A background article." Memsease do Instituto Oswaldo Cruz 102: 113-122. [3] Fauci, et al. 2011. Harrison's Principles of Internal Medicine.

Application Question/Issue

The life cycles of vector-based diseases are linked to environmental factors and land use patterns that can contribute to their emergence and spread. The quantification of environmental factors and estimates of the impacts of land use/land cover type change lend themselves to monitoring by remote sensing.

Who Cares and Why?

During World Health Day 2014, the World Health Organization's (WHO) Director-General, Dr. Margaret Chan, spoke of the devastating effects of many vector-borne diseases and warned of dengue's global spread, which has the potential to paralyze health systems and cause economic and social disruptions. A call went out from WHO for greater worldwide scientific support and understanding on how these disease vectors adapt to environmental and ecological changes throughout the world. Human alteration of both natural and agricultural ecosystems produces a mosaic of land use patterns that not only significantly impact disease vector life cycles, but also may directly determine the presence or absence of disease vectors. Global emerging diseases frequently occur in areas lacking basic climate/weather monitoring, having little information on land use patterns, and in remote, difficult-to-access areas with little government infrastructure and no epidemiological data. A critical need for global measurements of important environmental parameters significant in vector-borne disease life cycles can be addressed by NASA remote sensing satellites, data products, and models.

Needed Measurements

The availability of thermal data is critical to quantify important environmental parameters significant in disease vector life cycles. Factors such as soil moisture and type; soil organic matter content; surface, air and water temperatures; and vegetation phenology and species community composition are important in controlling the geographical extent and timing of disease vector life cycles. Year to year population variability responds strongly to climate and weather cycles. Also the initiation of many disease vector life cycles is triggered by the start of the rainy season. The best currently available thermal data from MODIS is at a 1km resolution, which does not quantify the fine scale habitat variability important in determining the disease vector's niche. Landsat provides better spatial resolution, but a 16-day repeat cycle makes it difficult to obtain data in many areas due to cloud cover. In addition, currently there are no satellites that provide routine global hyperspectral measurements critical in providing plant phenology/physiology measurements important in monitoring disease vector habitat or life cycle processes.

The NASA Response

The HyspIRI mission will provide hyperspectral visible and multispectral thermal data products enabling structural and functional classification of ecosystems and the measurement of key environmental parameters (temperature, soil moisture). HyspIRI 's 60-meter spatial resolution and approximately 5-day repeat pattern greatly enhances the ability to obtain timely and adequate thermal data. HyspIRI's NEdT (Noise Equivalent delta Temperature) precision of < 0.2 Kelvin will produce day-night pairs of calibrated surface temperatures for use in determining soil moisture, evaporation, and microclimate. The multispectral thermal bands will provide the capability of using wavelength dependent emissivity differences of minerals to map soil mineral composition, clay and organic matter content. The thermal measurements are particularly useful in providing approximately 5-day and day-night pairs of measurements of surface thermal environments.

The Hyperspectral data provided from HyspIRI allow spectroscopy at a spectral accuracy of < 0.5nm and an absolute radiometric accuracy of $> 95\%$ from vegetation canopies for the determination of species, species functional type, biochemistry, and physiological condition along with additional characterization of surface mineralogy. Thus the combination of hyperspectral visible and multi-spectral thermal data will significantly enhance out capability to map and monitor disease vector habitats.

Comments? Thoughts?

The HyspIRI website is designed to engage the community of practice, accept and process feedback and queries, support interactive workshops and disseminate user tutorials and other pertinent information. Comments and feedback can be posted at hyspiri@jpl.nasa.gov.