

The Hyperspectral Infrared Imager (HyspIRI) Public Health & Air Quality Applications

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Public Health

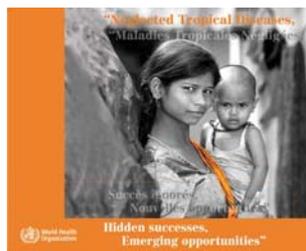
"The neglected tropical diseases (NTDs), a group of chronic, debilitating, and poverty-promoting parasitic, bacterial, and some viral and fungal infections, are among the most common causes of illness of the poorest people living in developing countries."^a

Abiotic environmental factors are important in determining the distribution of disease-causing vectors and their life-cycles.

- Temperature
- Precipitation
- Relative humidity
- Solar radiation
- Topography
- Soil moisture

Presence & extent of fresh water rivers, ponds, lakes

Biotic factors – ecosystem structure and health
Human factors- Land use, social-economic



WHO is currently focusing on 14 neglected tropical diseases:

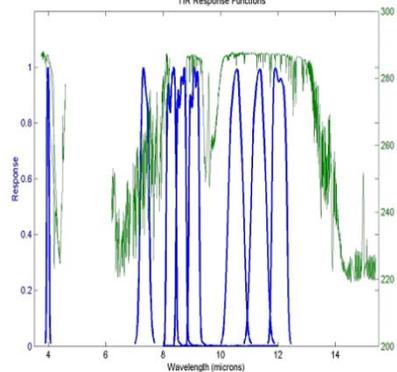
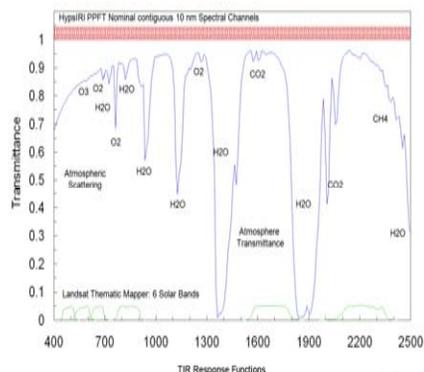
- Buruli ulcer
- Chagas disease
- Cholera/Epidemic diarrhoeal diseases
- Dengue/dengue haemorrhagic fever
- Dracunculiasis (guinea-worm disease)
- Endemic Treponematoses (yaws, pinta, endemic syphilis...)
- Human African trypanosomiasis
- Leishmaniasis
- Leprosy
- Lymphatic filariasis
- Onchocerciasis
- Schistosomiasis
- Soil-transmitted helminthiasis
- Trachoma

Major NTD Target Sub-Regions and Unique Ecologies.

| Scenario | Sub-Region | NTDs | Indigenous Populations | Co-Factors ^b |
|----------|---------------------------------------|--|------------------------|--|
| 1 | Southern cone of South America | Chagas, leishmaniasis, cysticercosis, echinococcosis, hemorrhagic fevers | + | Cattle ranching, minifundios, urban migration |
| 2 | Chaco (Bolivia, Paraguay, Argentina) | Chagas, leishmaniasis, STH | +++ | Cattle ranching, minifundios, animal husbandry |
| 3 | Andean region (Altiplano or Highland) | Fascioliasis, Chagas, leishmaniasis, plague, bartonellosis, STH, cysticercosis, echinococcosis, ectoparasites | ++++ | Minifundios, urban migration |
| 4 | Amazonian basin | Chagas, leishmaniasis, STH, onchocerciasis, leprosy, trachoma, ectoparasites | ++ | Deforestation, mining, guerillas, urban migration, indiscriminate colonization |
| 5 | Eastern Brazil | STH (esp. hookworm) schistosomiasis, Chagas disease, leishmaniasis, LF (NE only), echinococcosis, leprosy, leptospirosis | ++ | Cattle ranching, deforestation, minifundios, urban migration, monoculture |
| 6 | North Pacific of South America | STH, cysticercosis, leishmaniasis, onchocerciasis, echinococcosis | ++ | Deforestation, gold mining, guerillas |
| 7 | Caribbean basin | STH, schistosomiasis, LF, leprosy, leptospirosis, fascioliasis | + | Economic dependence on tourism, deforestation, urban migration |
| 8 | Central America and Panama | STH, leishmaniasis, Chagas, onchocerciasis, cysticercosis, leptospirosis | +++ | Deforestation, desertification, migration |
| 10 | South and Central Mexico | STH, Chagas, cysticercosis, leishmaniasis, trachoma, echinococcosis | +++ | Deforestation, migration |
| 11 | Northern Mexico | STH, Chagas, cysticercosis, leishmaniasis | ++ | Desertification, migration |

^aHotez PJ, Molyneux DH, Fenwick A, Kumaresan J, Ehrlich Sachs S, et al. Control of neglected tropical diseases. *New Eng J Med.* 2007;357:1018–1027.

^bP. J. Hotez, M. E. Bottazzi, C. Franco-Paredes, S. K. Ault, and M. R. Periago. 2008 The Neglected Tropical Diseases of Latin America and the Caribbean: A Review of Disease Burden and Distribution and a Roadmap for Control and Elimination. *PLoS Negl Trop Dis.* 2008 September; 2(9): e300.



Air Quality (Dust)^c

HyspIRI hyperspectral measurements would provide global measurements of surface mineralogy and biotic crusts important in accessing the impact of dust in human health.

HyspIRI surface thermal measurements would also help identify the variability of dust sources due to surface moisture conditions and map mineralogy

The Health Effects of Dusts

- Some aspects have been well known for decades
 - General effects of industrial / commercial asbestos
 - Silicosis (hard rock mining)
 - Black lung (coal mining)
- New issues and problems are arising
 - Effects of mineral dust (ie, trace asbestos)
 - Valley fever (Coccidioidomycosis)
 - Trans-oceanic dust transport

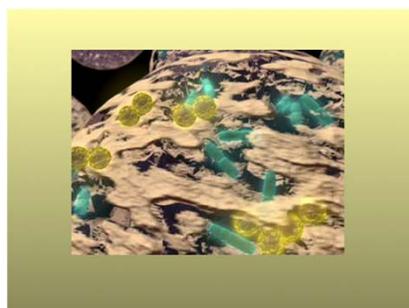
Biotic Crusts: where the action is

Middle East Dust – Trace Composition

Links between selected elements and some known lung function conditions and diseases

| | Desert Dust <10 µm | Desert Dust 20-40 µm |
|---------------------------------|--------------------|----------------------|
| Mn (ppm) | 450 | 331.98 |
| V (ppm) | 25500 | 18111.61 |
| Co (ppm) | 11.72 | 8.24 |
| Pb (ppm) | 17.22 | 9.45 |
| Cu (ppm) | 220 | 152.64 |
| Cd (ppm) | 1.24 | 0.70 |
| Mg (ppm) | 13230.49 | 10572.70 |
| Al (ppm) | 15912.39 | 13154.60 |
| Ca (ppm) | 139577.64 | 140250.15 |
| Na (ppm) | 1098.28 | 1476.86 |
| Cr (ppm) (but species critical) | 181.32 | 187.36 |
| Zn (ppm) | 105.18 | 72.30 |
| Ni (ppm) | 93.28 | 60.44 |
| Ti (ppm) | 1095.52 | 539.81 |

Legend: Cancer (red), Cancer suspected (orange), Cancer & asthma (yellow), Emphysema (green), Asthma (blue)



HyspIRI observations can be merged through a Land Data Assimilation System (LDAS) be used to drive spatially-explicit ecological models of NTD vectors distribution & life cycles. Assimilations will be driven by observational data LDAS and satellite-derived meteorological forcing data, parameter datasets, and assimilation observations, including:

- Precipitation from TRMM, and GPM
- Land Cover Type from HyspIRI
- Soil Moisture from AMSR-E (where applicable), SMAP and HyspIRI.
- Terrestrial Water Storage from GRACE and GRACE II.
- Surface temperature, Vegetation Fraction/ Leaf Area Index, and canopy physiology from HyspIRI.
- Topography from SRTM.

Kuwait dust, Camp Buehring, size fraction 10 to 20µm

This photo shows a particle that appears to contain numerous bacteria in its core rather than on its surface. Bacteria size ~1µm. 1000X with digital zoom.

Sterilization Problems!

Labels: Particle edge, bacteria, grouped bacteria, Individual and grouped bacteria, bacteria, Virus-like particle.

^c Used with permission of Dr. Mark B. Lyles VADM Joel T. Boone Chair Of Health And Security Studies Center For Naval Warfare Studies U.S. Naval War College Newport, Rhode Island Mark.Lyles@usnwc.edu