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

Jeffrey C. Luvall [1] & Simon J. Hook [2]
Marshall Space Flight Center [1] & Jet Propulsion Laboratory [2]

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

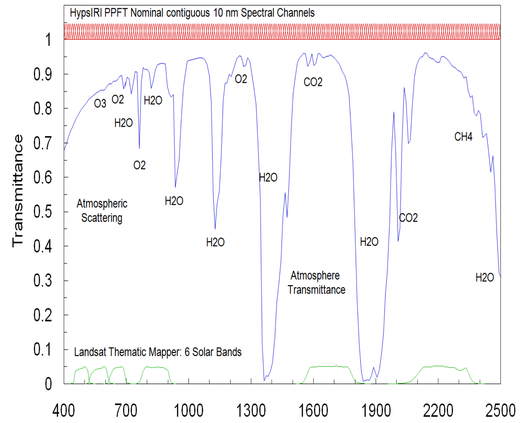
WHO is currently focusing on **14** neglected tropical diseases:

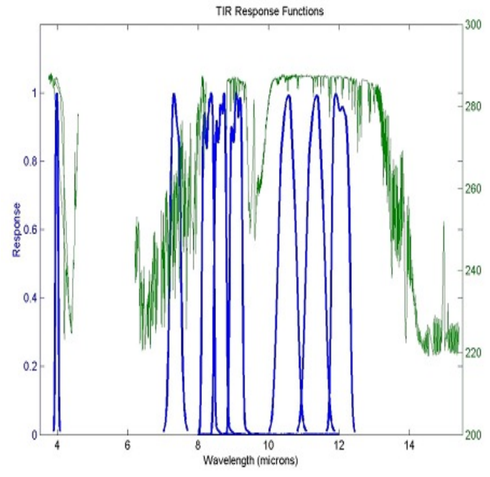
- Buruli ulcer
- Chagas disease
- Cholera/Epidemic diarrhoeal diseases
- Dengue/dengue haemorrhagic fever
- Dracunculiasis (guinea-worm disease)
- Endemic Treponematoses (yaws, pinta, endemic syphilis…)
- Human African trypanosomiasis
- Leishmaniasis
- Leprosy
- Lymphatic filariasis
- Onchocerciasis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

b

Major NTD Target Sub-Regions and Unique Ecologies.

Scenario	Sub-Region	NTDs	Indigenous Populations	Co-Factors[a]
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, indiscriminant 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, cystiercosis, 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, cystiercosis, leishmaniasis, trachoma, onchocerciasis	+++	Deforestation, migration
11	Northern Mexico	STH, Chagas, cysticercosis, leishmaniasis	++	Desertification, migration





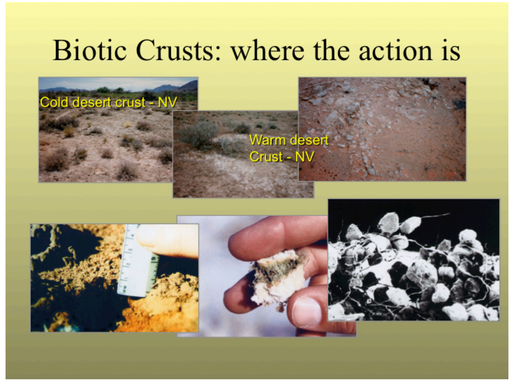
HyspIRI observations can be merged through a Land Data Assimilation System (LDAS) be used to drive spatially-explicit ecological models of NTD vectors distribution & life cycles.
Assimilations will be driven by observational data LDAS and satellite-derived meteorological forcing data, parameter datasets,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

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

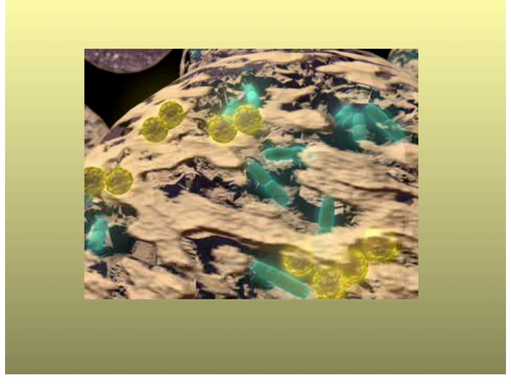


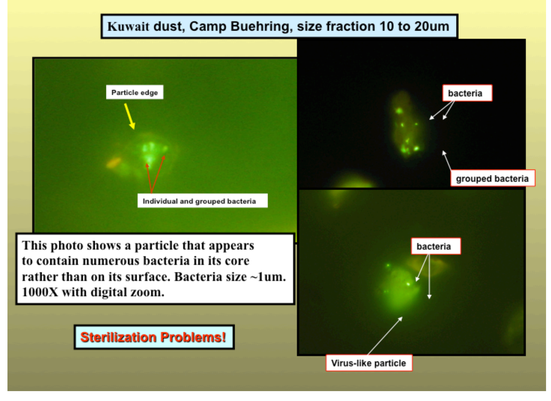
Middle East Dust – Trace Composition

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
Fe (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

Cancer | Cancer suspected | Cancer & asthma | Emphysema | Asthma





[a] Hotez 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.

[b] P. 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.

[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