

# Use of Remote Sensing/Geographical Information Systems (RS/GIS) to identify Environmental Limits of Soil Transmitted Helminthes (STHs) Infection in Boaco, Nicaragua



*Max J. Moreno Madriñán, David G. Parajón, Roberto Martinez, Mohammad Z. Al-Hamdan, Douglas. L. Rickman, Laura Parajón, and Sue Estes*

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# Presentation Overview

- **Background of the Diseases**
  - ✧ Helminthiasis (Neglected Diseases)
  - ✧ Sanitation
  - ✧ Health Impact
- **Study Area**
  - ✧ Boaco, Nicaragua
- ***In situ* data from AMOS**
- **Remote Sensing**
  - ✧ MODIS Land Surface Temperature (LST)
  - ✧ MODIS Normalized Difference Vegetation Index (NDVI)
  - ✧ MODIS Land Cover Land Use Type (LCLU)
- **Results**
- **Conclusions**
- **Recomendations**

# Background



Source: Thor Axel Stenström, 2009

- **Environment is a major factor for health, both directly or indirectly**
  - ❖ Sanitation, poverty, neglected diseases
  - ❖ Natural environment
- **A number of agents of diseases are carried by vectors and reservoirs whose viability depends on given environmental conditions**
- **Such conditions describe not only the characteristics of the natural environment but also of sanitation**
- **Such conditions can be inferred with satellite data**
  - ❑ Temperature
  - ❑ Vegetation
  - ❑ Presences of water bodies
  - ❑ Elevation
  - ❑ Soil moisture
  - ❑ Precipitation

\* WHO, 2002. The World Health Report: Reducing Risks , Promoting Healthy Life

# Background cont.



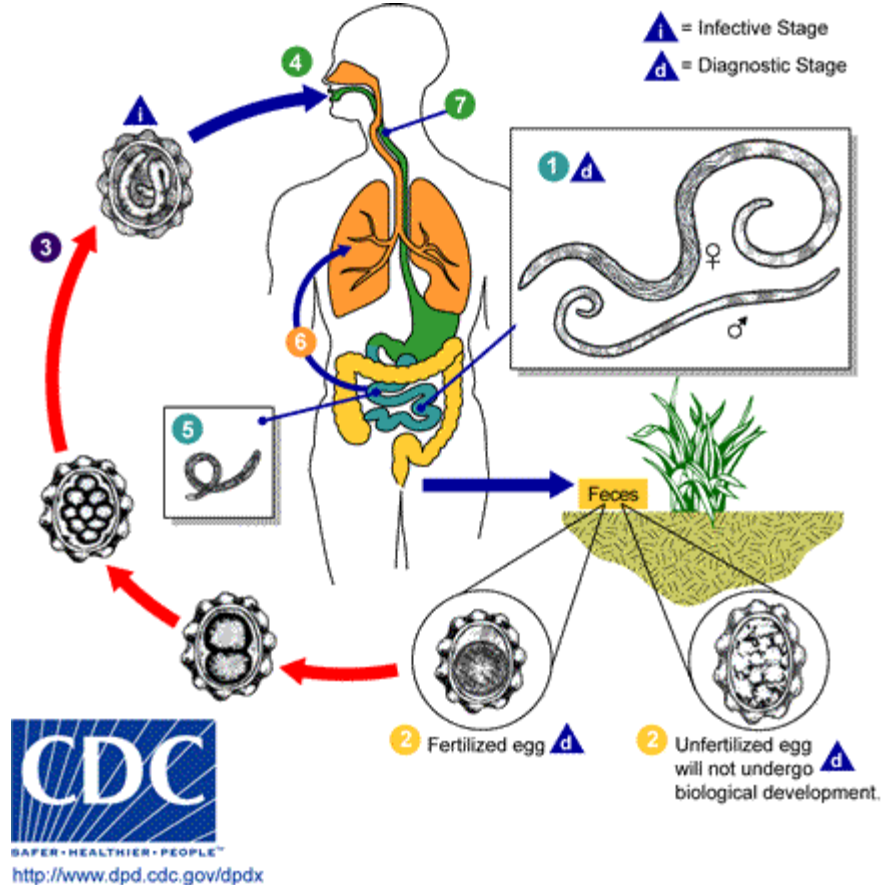
Photo courtesy Dr. Ligia Cruz Espinoza

- Soil transmitted helminthes infection, Helminthiasis, Neglected Diseases
- Impact
  - ✧ Reduced physical growth
  - ✧ Weak physical fitness
  - ✧ Impaired cognitive functions
  - ✧ Increase with intensity of infections

1. UNICEF, 2006. Progress for Children

# Background cont.

- *Ascaris lumbricoides*
- Life cycle
- 2 to 3 months after ingestion of the eggs, the mature worms commence egg laying in the intestine
- 2 or 3 weeks outside the host to develop to the infective stage



# Background cont.

- **Microscopic Evaluation**



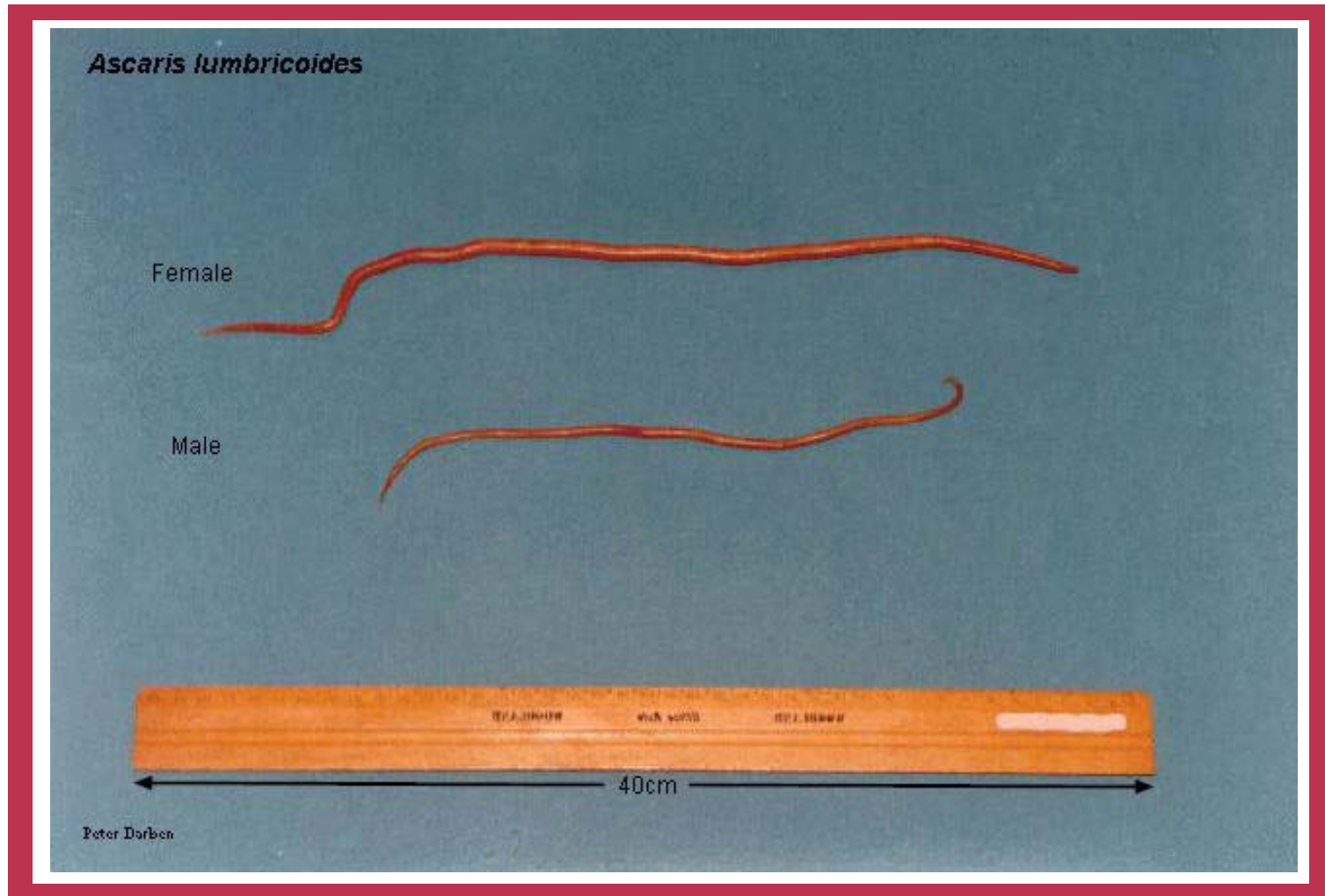
*Ascaris suum* zygotes  
inactivated



*Ascaris suum* developed  
larva

Photos Courtesy of Dr. Ligia Cruz Espinoza

# Background cont.



[http://curezone.com/image\\_gallery/parasites/ascaris/](http://curezone.com/image_gallery/parasites/ascaris/)

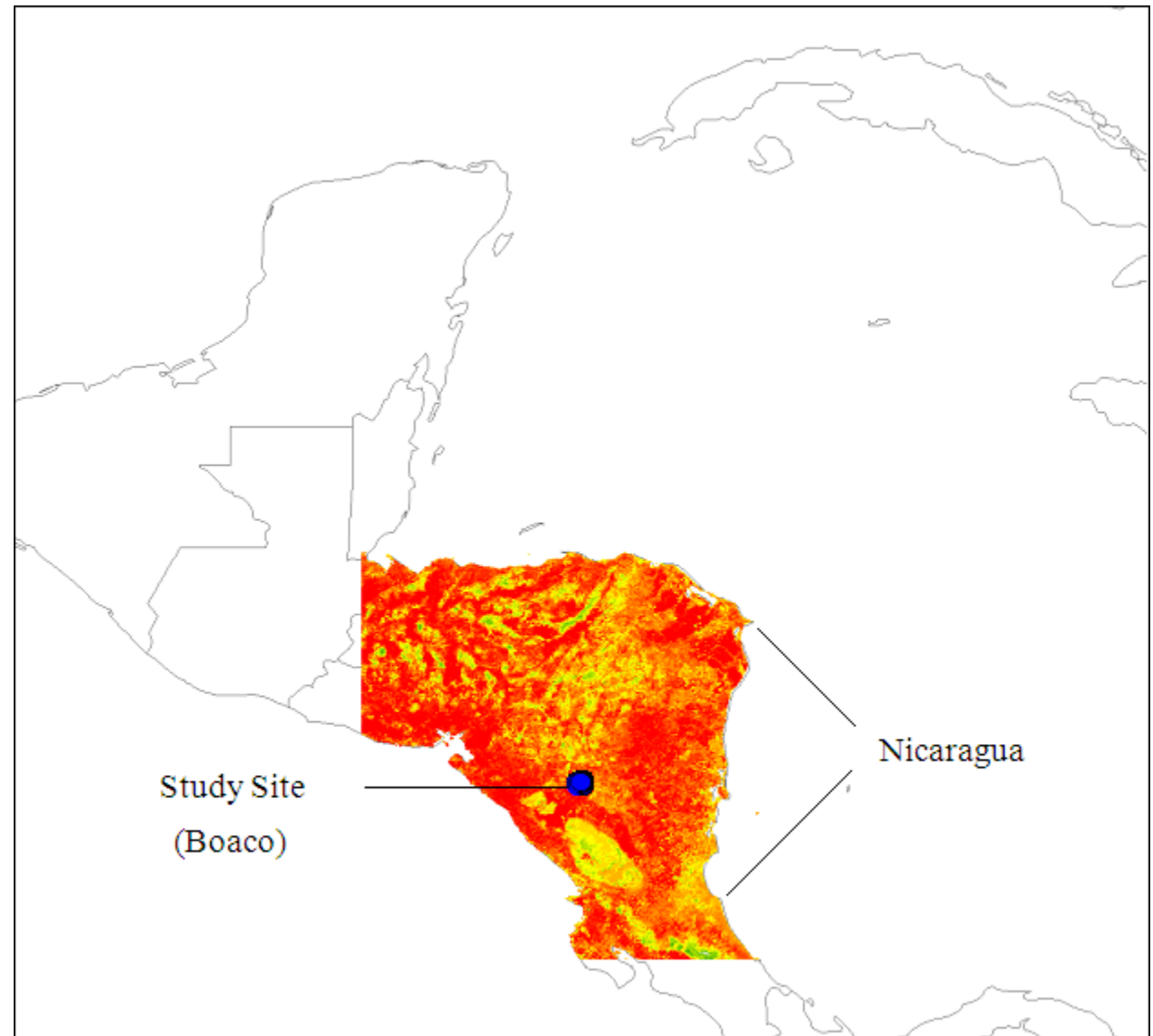
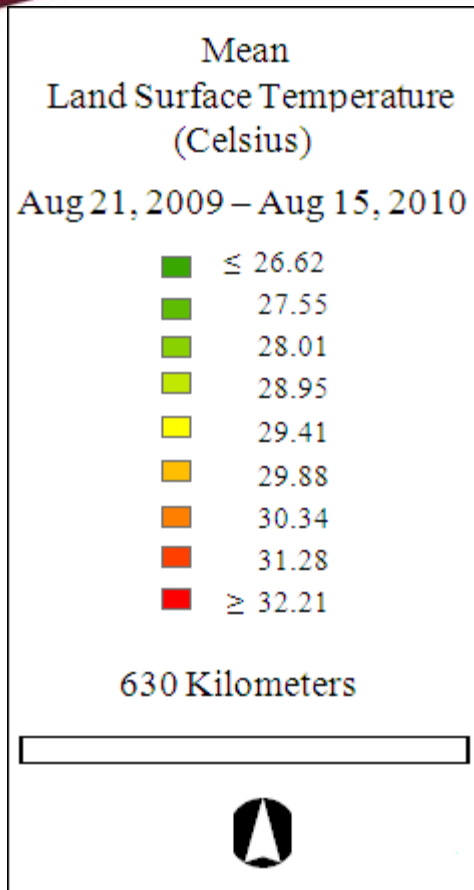
# *In situ* data

- *Ascaris lumbricoides*
- *Trichuris trichiura*
- *Ancilostoma duodenale*
  
- **AMOS Health & Hope**
- **[http://www.amoshealthandhope.org/Health\\_for\\_all/Home.html](http://www.amoshealthandhope.org/Health_for_all/Home.html)**





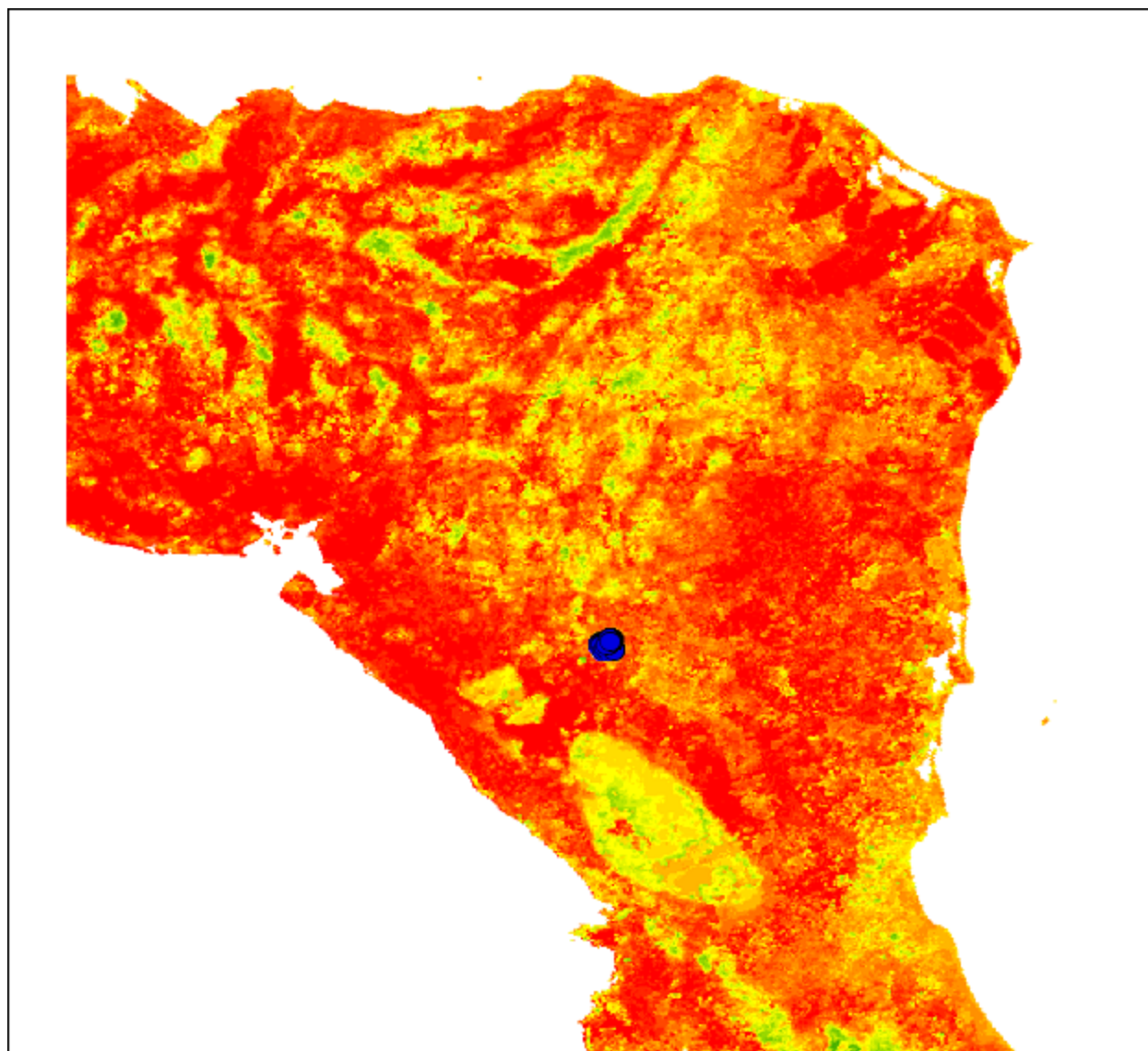
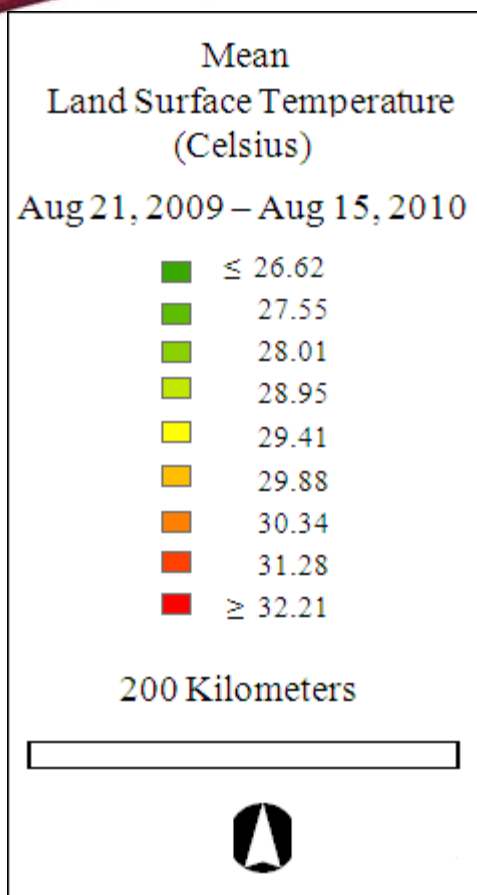
# Study area



- MODIS Land Surface Temperature (LST)  
1:30 pm
- MYD11A1 1 km daily



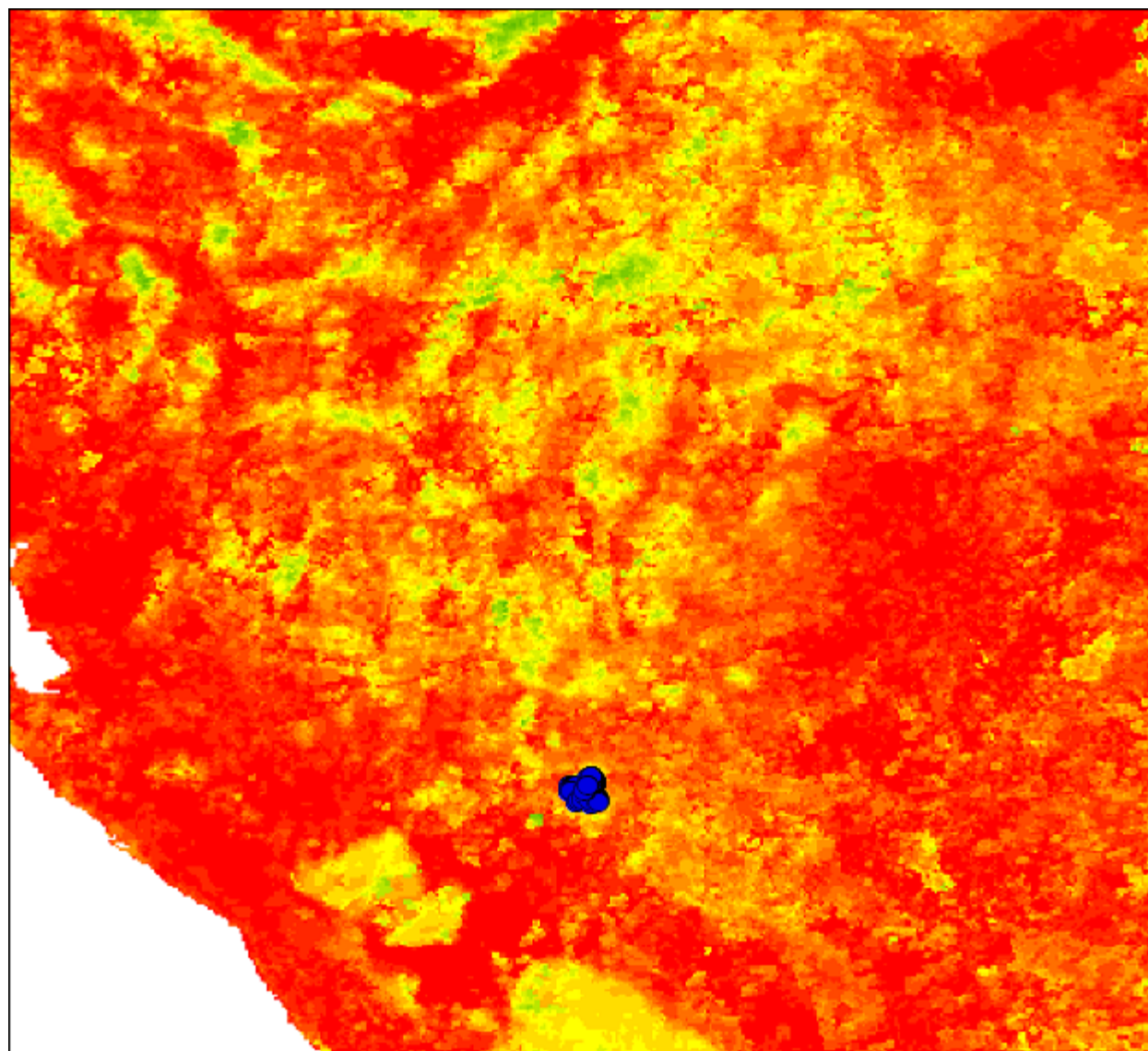
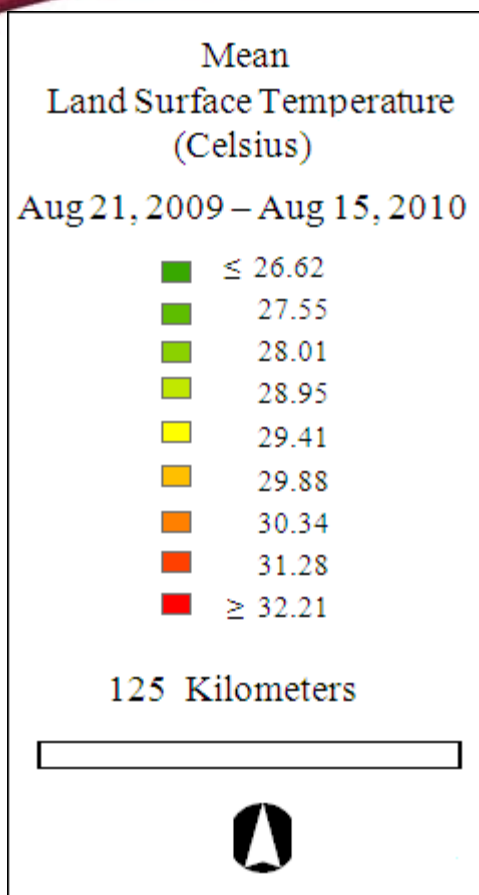
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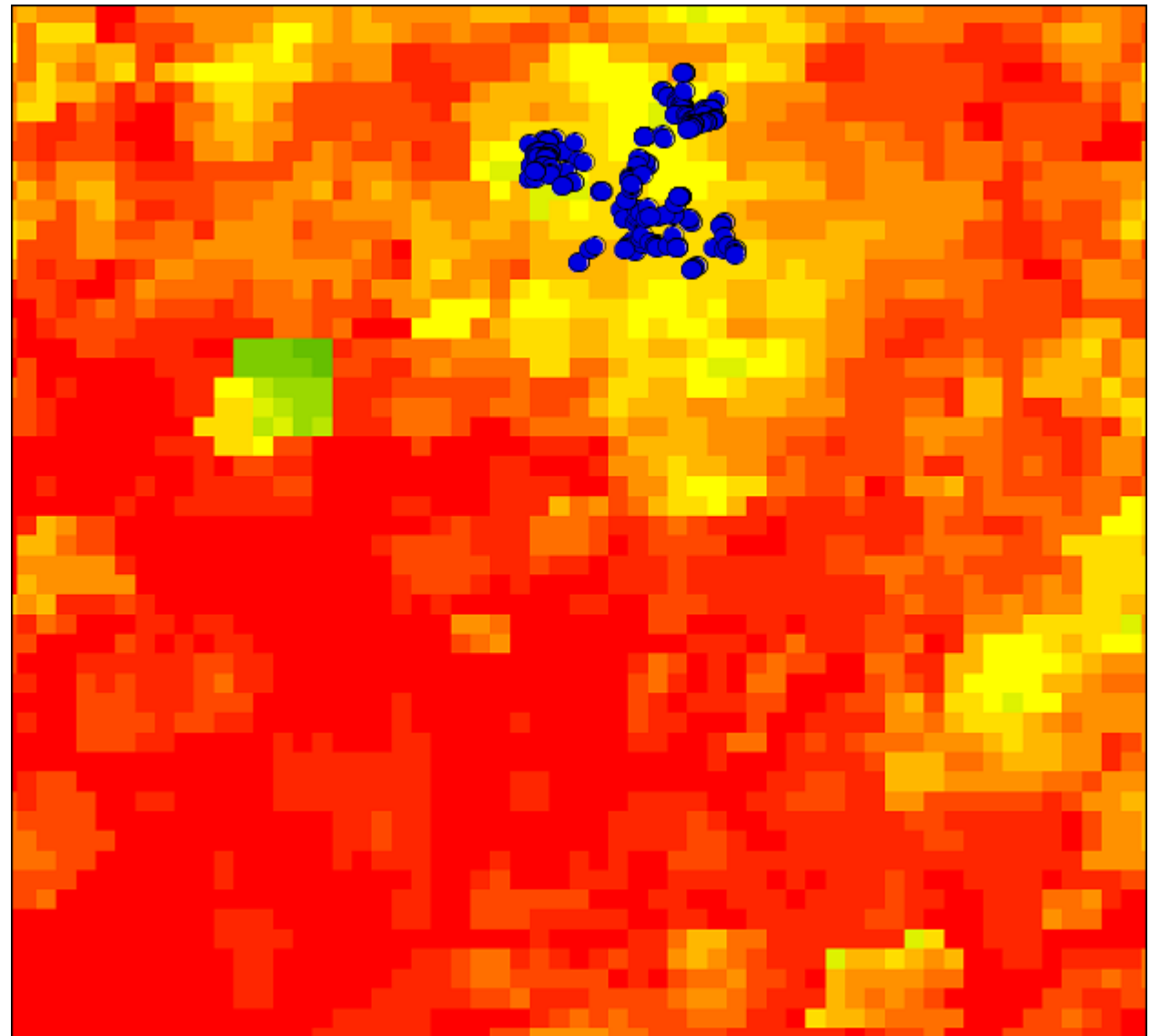
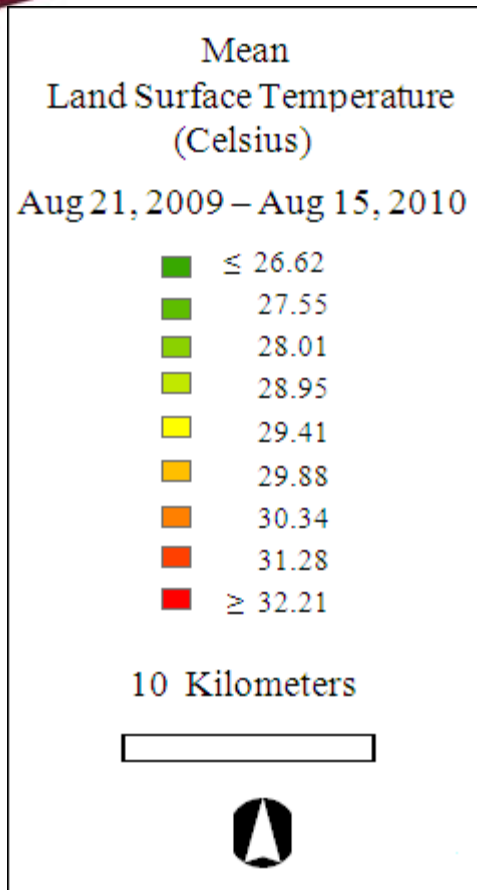
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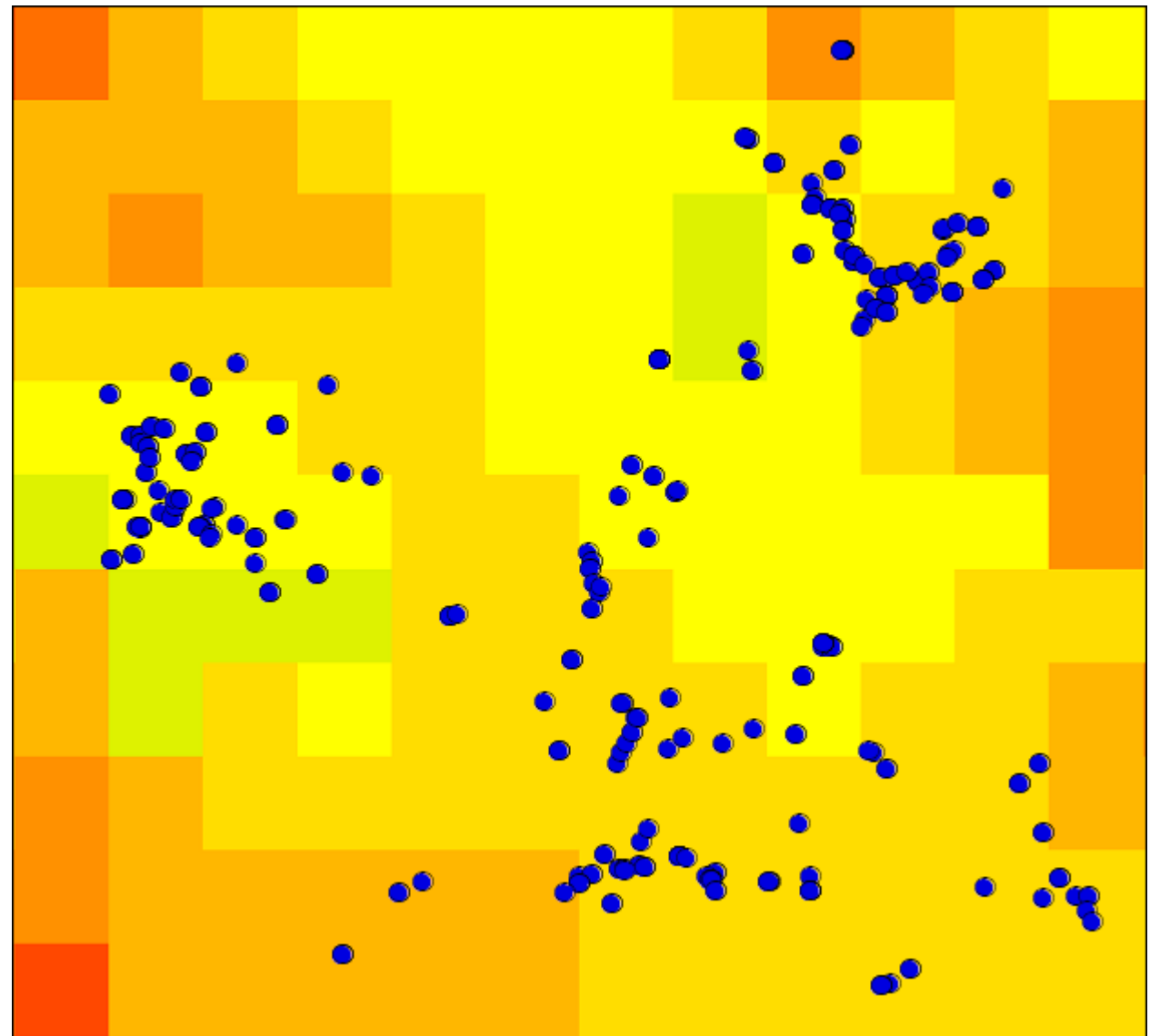
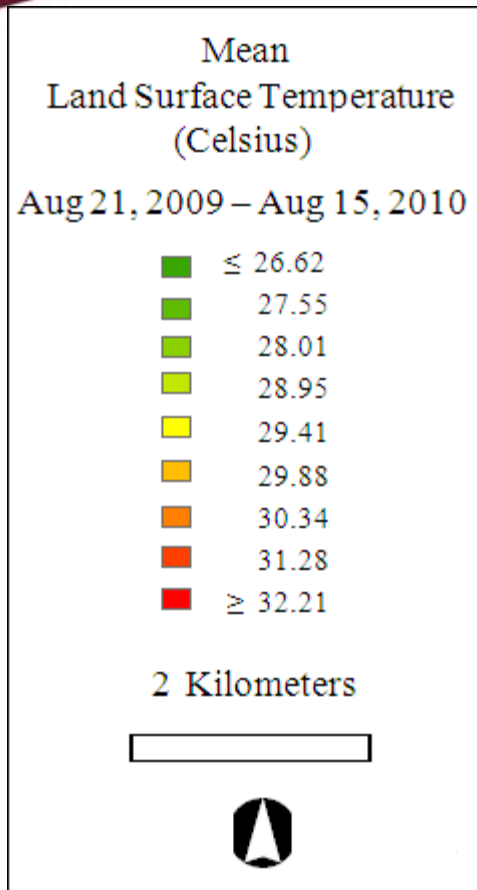
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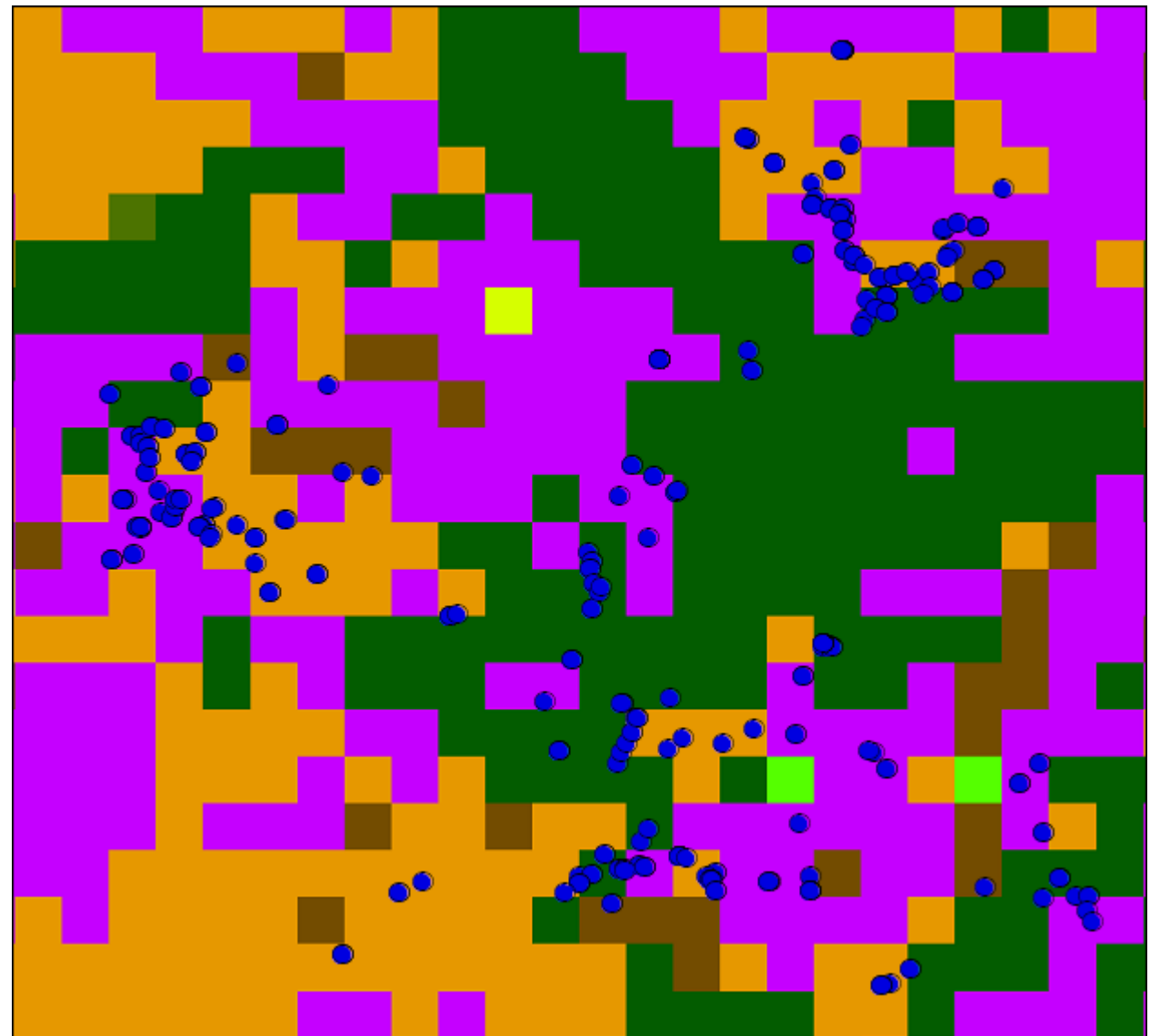
# Remotely sensed data



- MODIS Land Surface Temperature (LST)  
1:30 pm
- MYD11A1 1 km daily



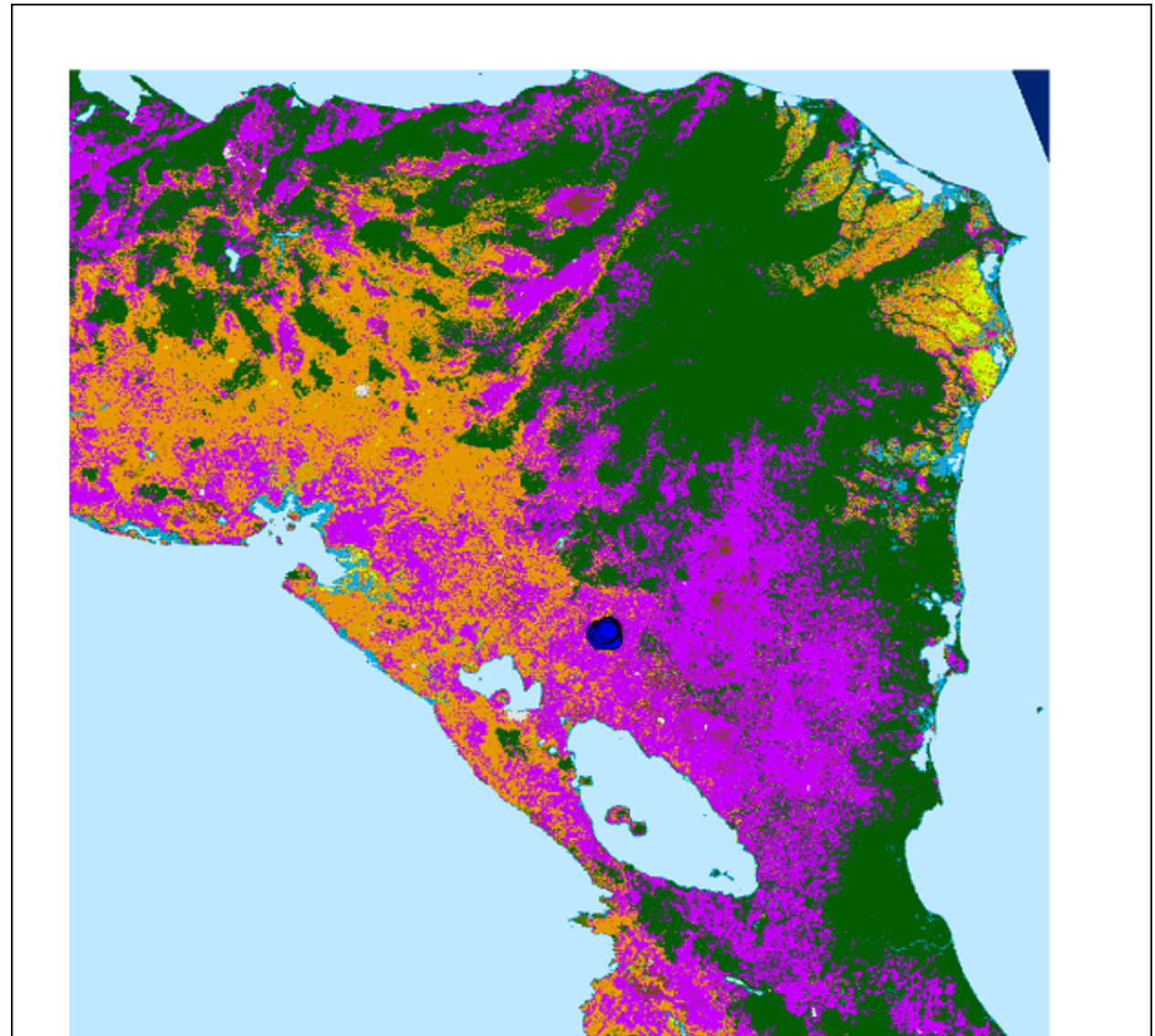
# Remotely sensed data



- MODIS Land Cover Land Use (LCLU)
- MCD12Q1 Combined
- 500 m Yearly



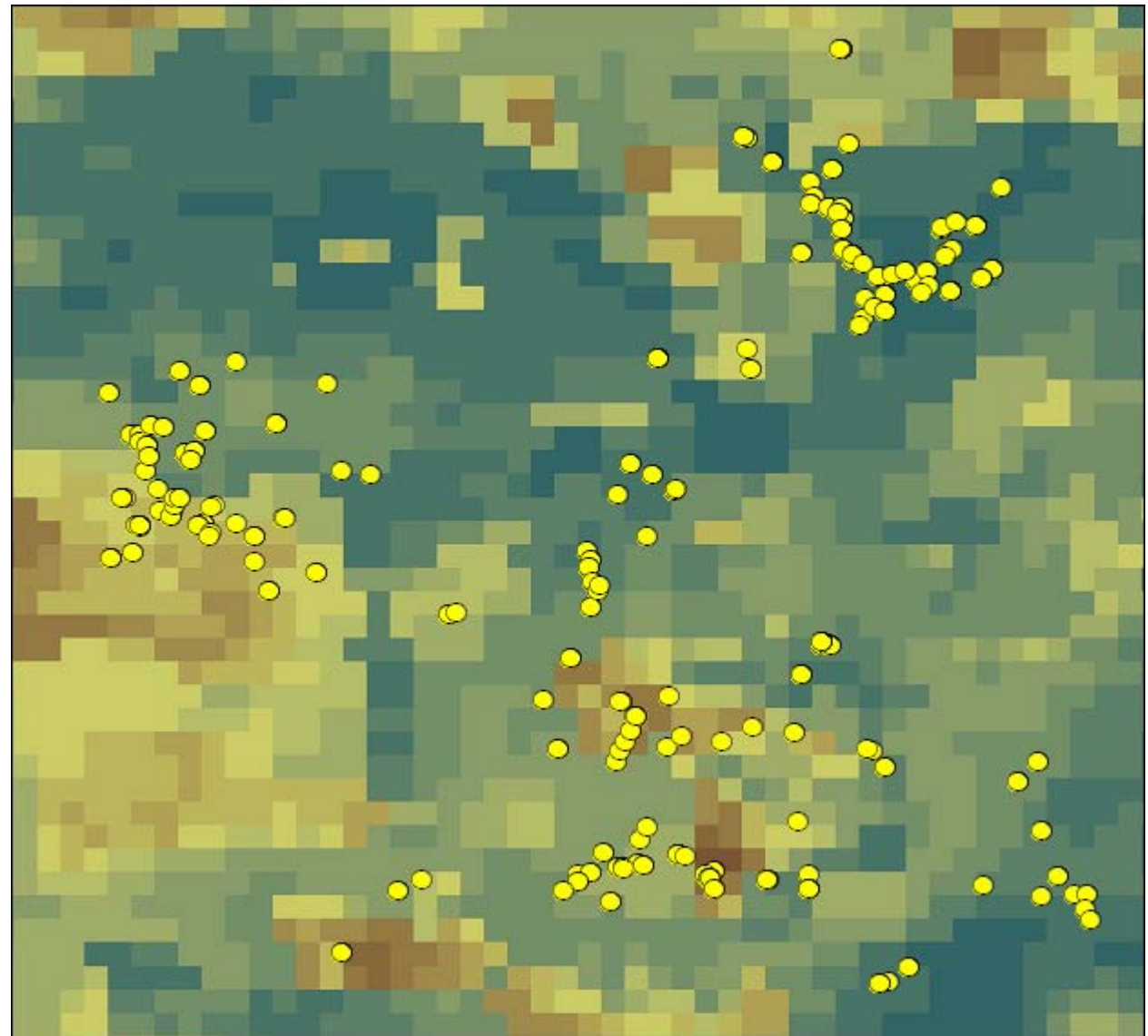
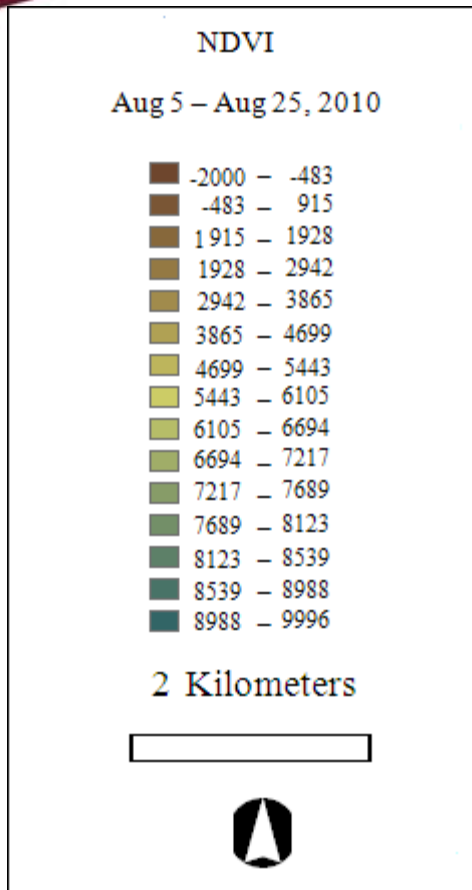
# Remotely sensed data



- MODIS Land Cover Land Use (LCLU)
- MCD12Q1 Combined
- 500 m Yearly



# Remotely sensed data

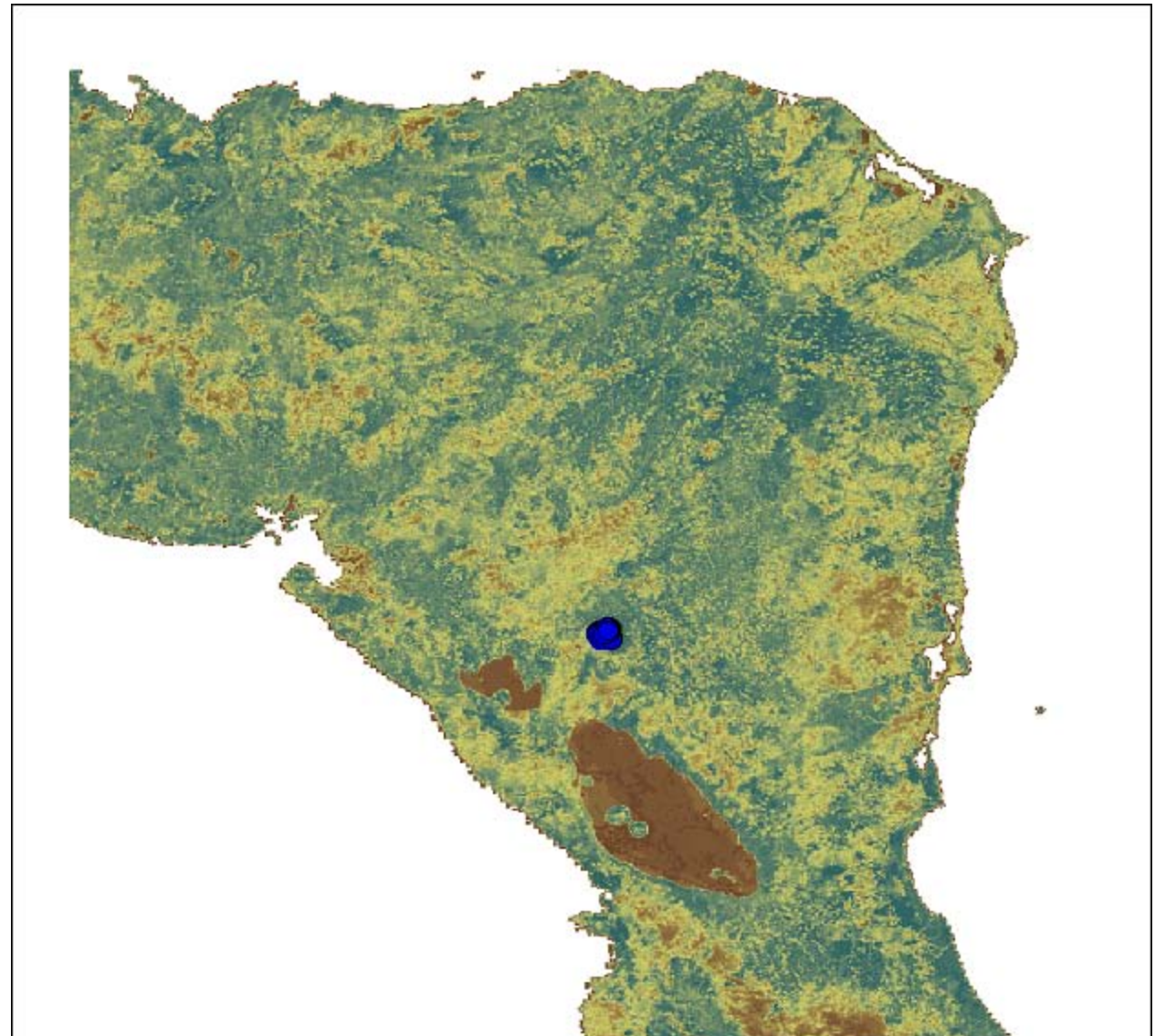
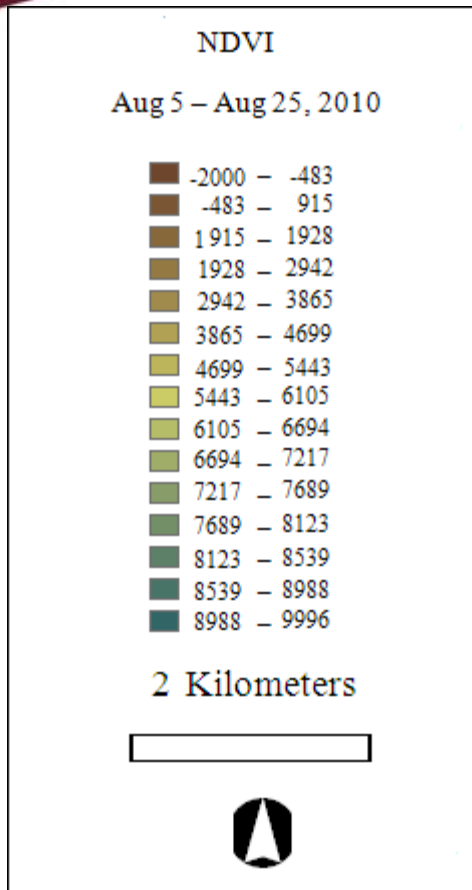


- MODIS Normalized Difference Vegetation Index (NDVI) 16 days
- MYD13Q1 250 m





# Remotely sensed data

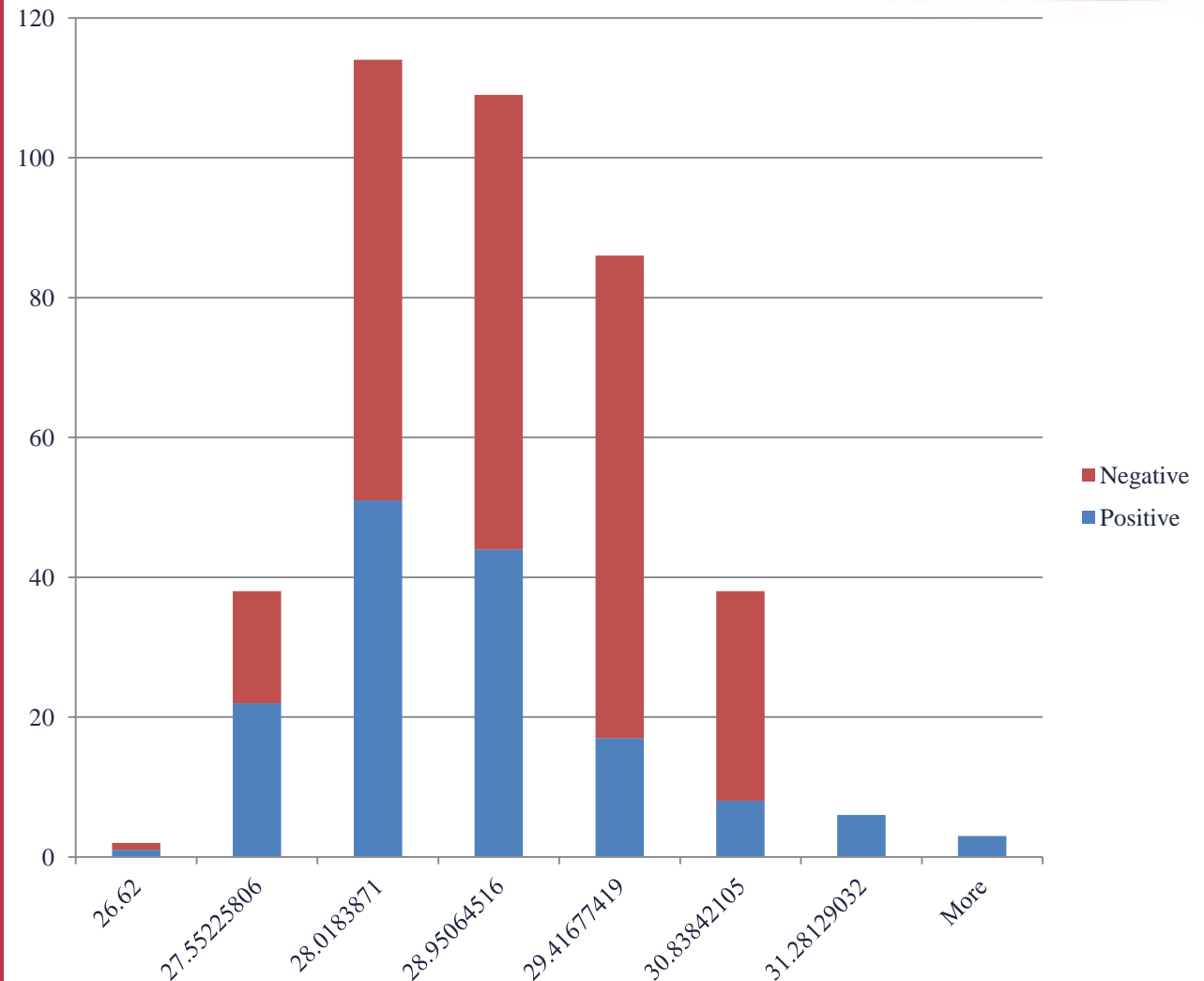


- MODIS Normalized Difference Vegetation Index (NDVI) 16 days
- MYD13Q1 250 m

# LST & *Trichuris trichuria*

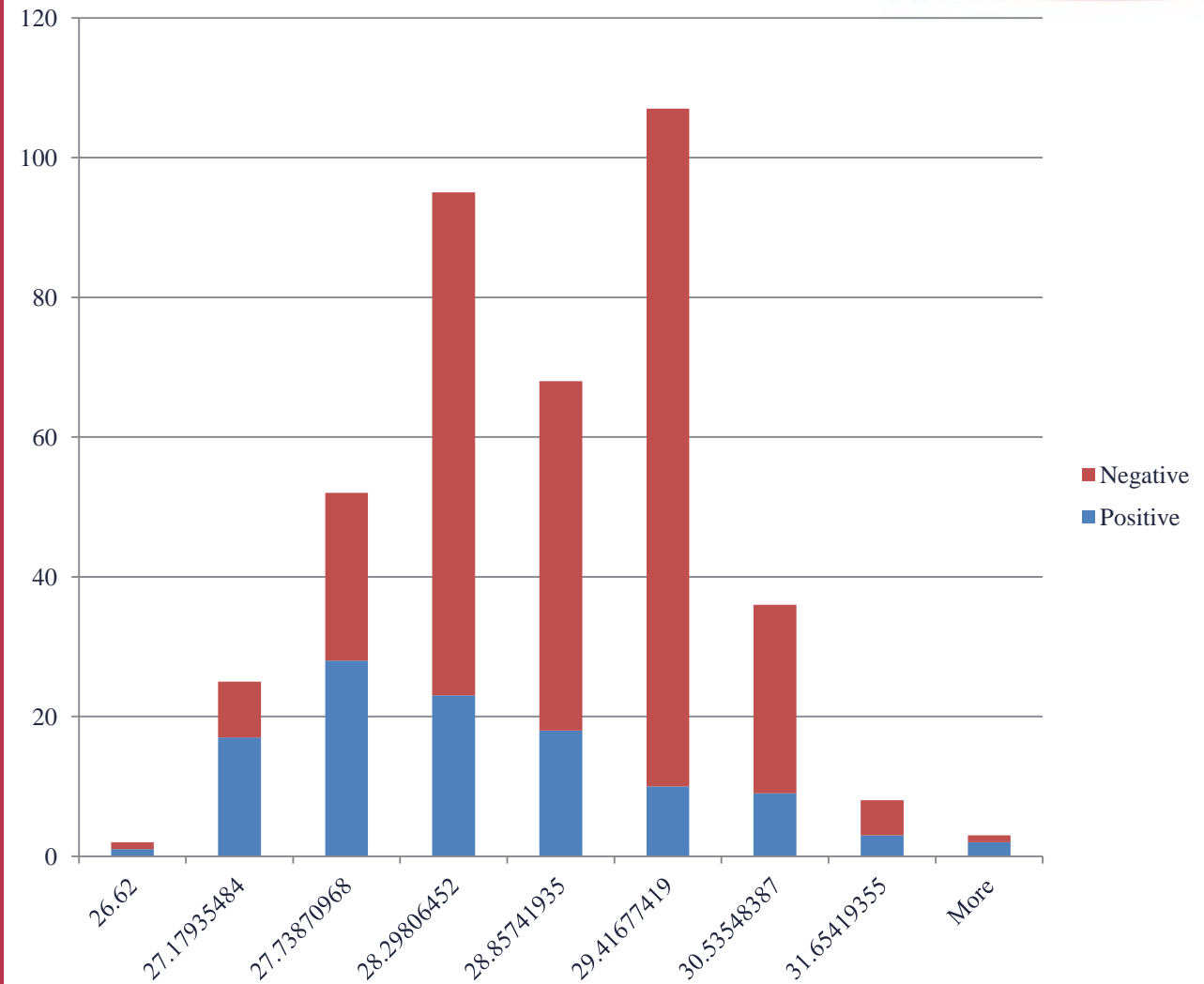


- Wilcoxon Two-Sample Test:
- Normal Approximation
- $Pr > |z| = 0.0157$
- t Approximation
- $Pr > |z| = 0.0161$
- Kruskal-Wallis Test
- $Pr > \text{Chi-Square} = 0.0156$
- Positive:  $n=152$   
mean=26.27
- Negative:  $n=244$   
mean=26.47



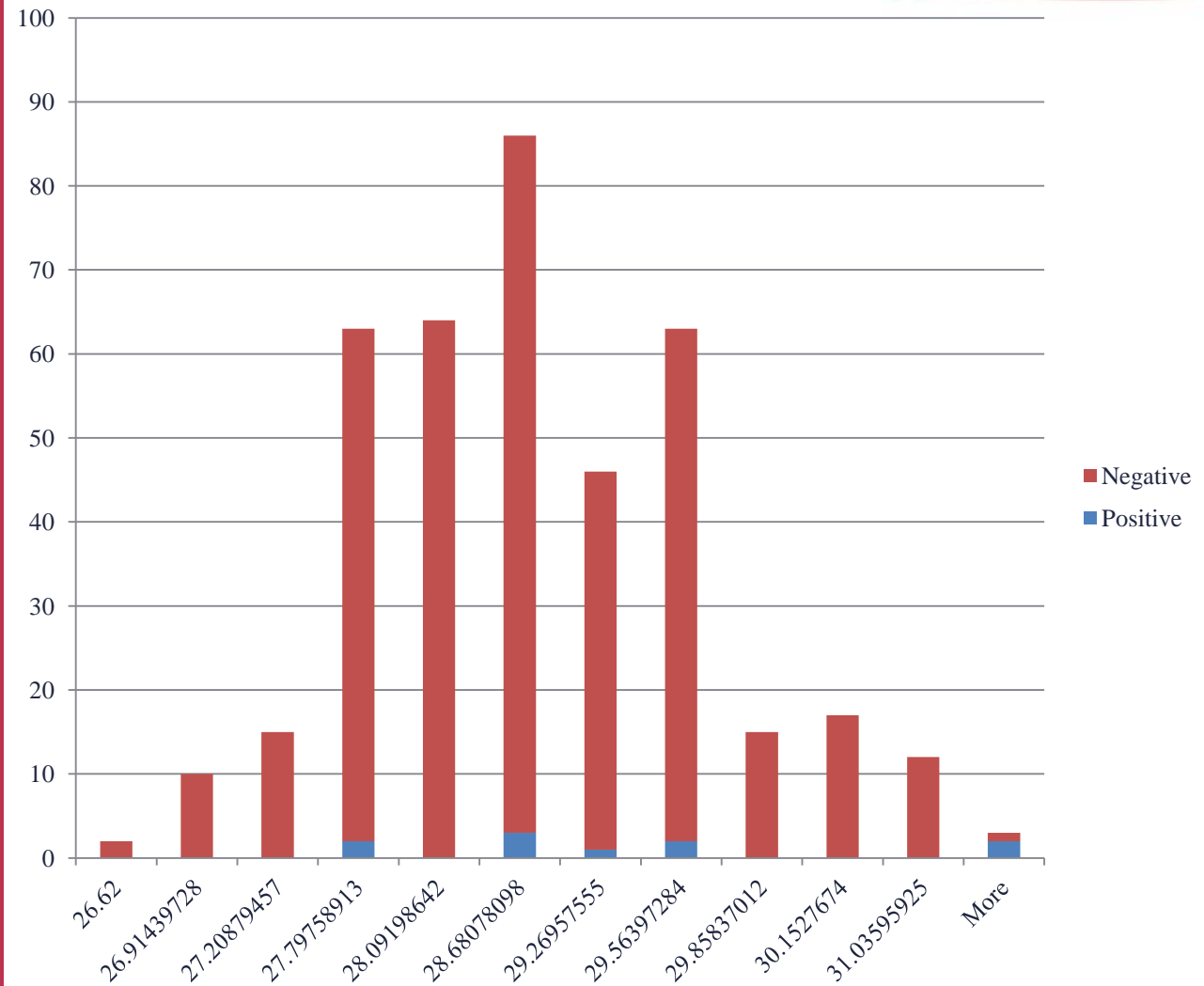
# LST & *Ascaris lumbricoides*

- Wilcoxon Two-Sample Test:
- Normal Approximation
- $Pr > |z| < 0.0001$
- t Approximation
- $Pr > |z| < 0.0001$
- Kruskal-Wallis Test
- $Pr > \text{Chi-Square} < 0.0001$
- Positive: n=111  
mean=26.13
- Negative: n=285  
mean=26.49



# LST & *Ancilostoma duodenale*

- Wilcoxon Two-Sample Test:
- Normal Approximation
- $Pr > |z|$  0.7824
- t Approximation
- $Pr > |z|$  0.7825
- Kruskal-Wallis Test
- $Pr > \text{Chi-Square}$  0.7813
- Positive: n=10  
mean=26.61
- Negative: n=386  
mean=26.39





# Land Cover

Prevalence considering all three parasites together

- Evergreen broad leaf forest
- Woody savannas
- Croplands
- Croplands/natural vegetation mosaic

Land Class	Posit.	Negat.	Odds ratio	n	Prevalence
2	44	54	0.814	98	0.45
8	48	69	0.695	117	0.41
12	6	10	0.6	16	0.37
14	91	74	1.23	165	0.55

# Preliminary Conclusions

- Although not clear limits could be suggested for any of the species of soil transmitted helminthes considered, a mean LST greater than 30.8 Celsius at 1:30 PM seems to be more favorable for prevalence of *Trichuris trichuria*.
- As expected, the prevalence of infection for all three species seems to increase with the increase of LST
- MODIS LST shows potential as a tool to identify areas at risk of Helminthiasis however studies covering larger range in temperature are needed to more clearly show such applicability
- Due probably to the small area of the study site, it was not possible to suggest the applicability of MODIS Normalized Difference Vegetation Index (NDVI) and Land Cover under the study conditions

# Max Jacobo Moreno Madriñán

[max.j.moreno-madrinan@nasa.gov](mailto:max.j.moreno-madrinan@nasa.gov)



