



DEVELOP

National Aeronautics and
Space Administration



Leveraging Earth Observations and Health Data to Map Outbreak Risk and Inform Public Health Interventions for Zoonotic Disease Prevention

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Pecora 22



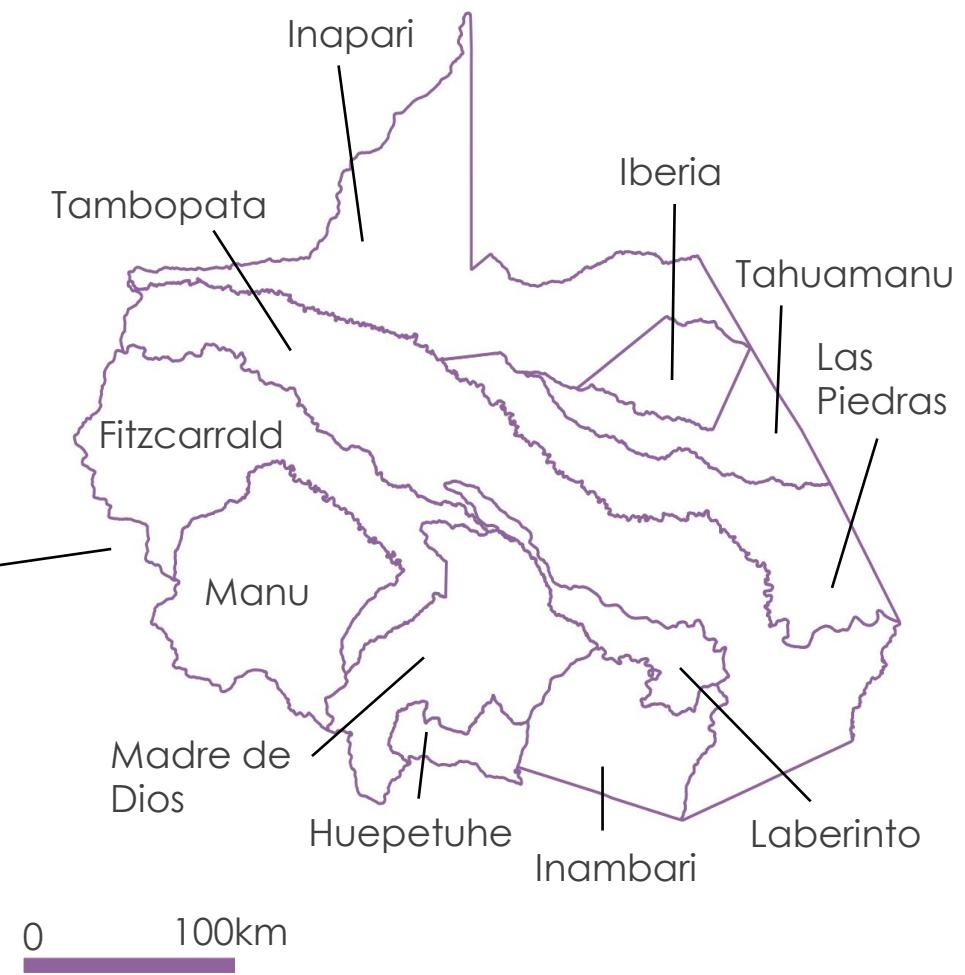
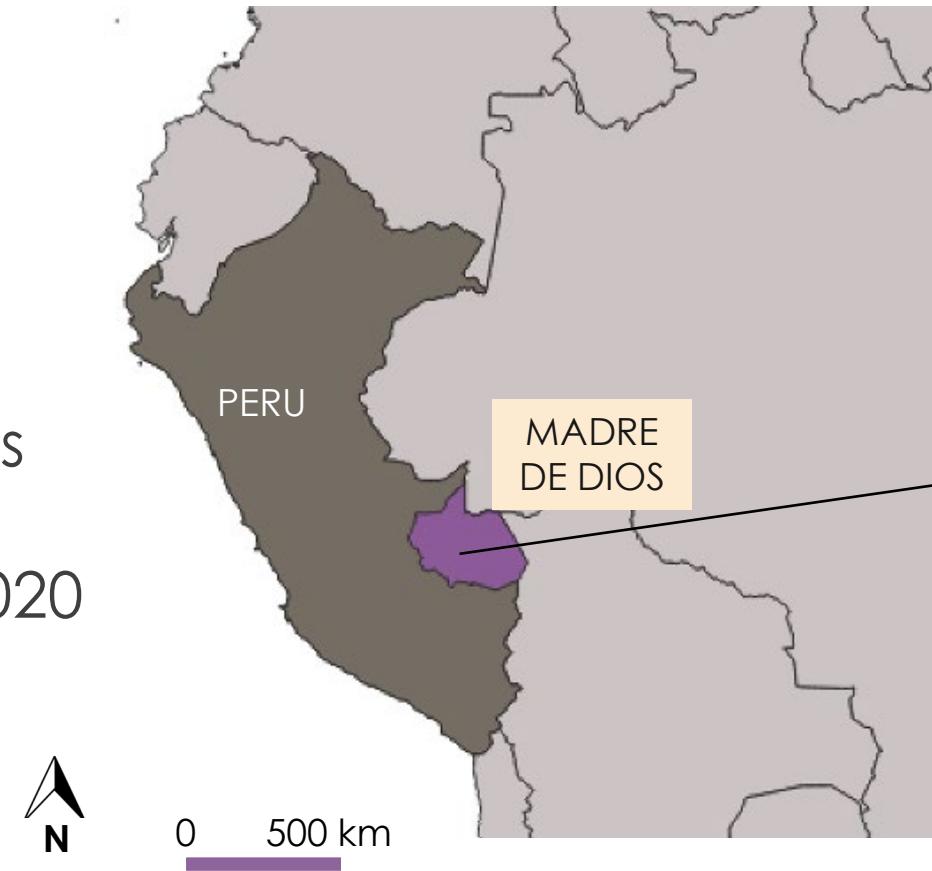
Study Area & Period

Country: Peru

Region: Madre de Dios

Area: 11 districts

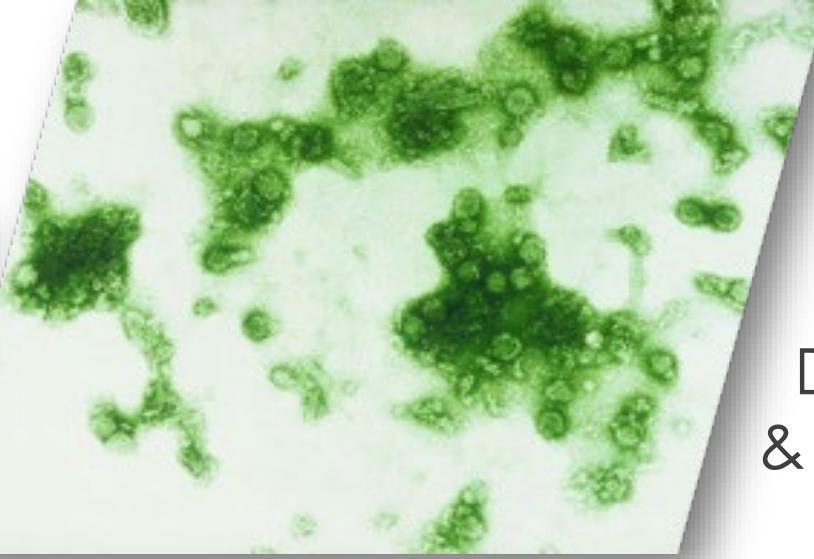
Years: 2010 – 2020



Community Concerns



Changing Land Use



Endemic
Dengue Fever
& Leishmaniasis



Expanding
Vector Habitats





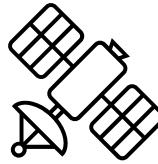
Partners



**Peru Ministry of Health
(MINSA)**



The Lab for EcoHealth &
Urban Ecology at la
Universidad Peruana
Cayetano Heredia



The National Commission for
Aerospace Research and
Development (CONIDA)



**Peru Ministry of Environment
(MINAM)**



El Instituto del Bien Común (IBC)



La Asociación para la Conservación
de la Cuenca Amazónica (ACCA)



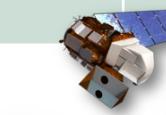
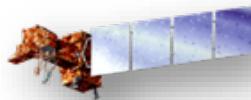
Objectives



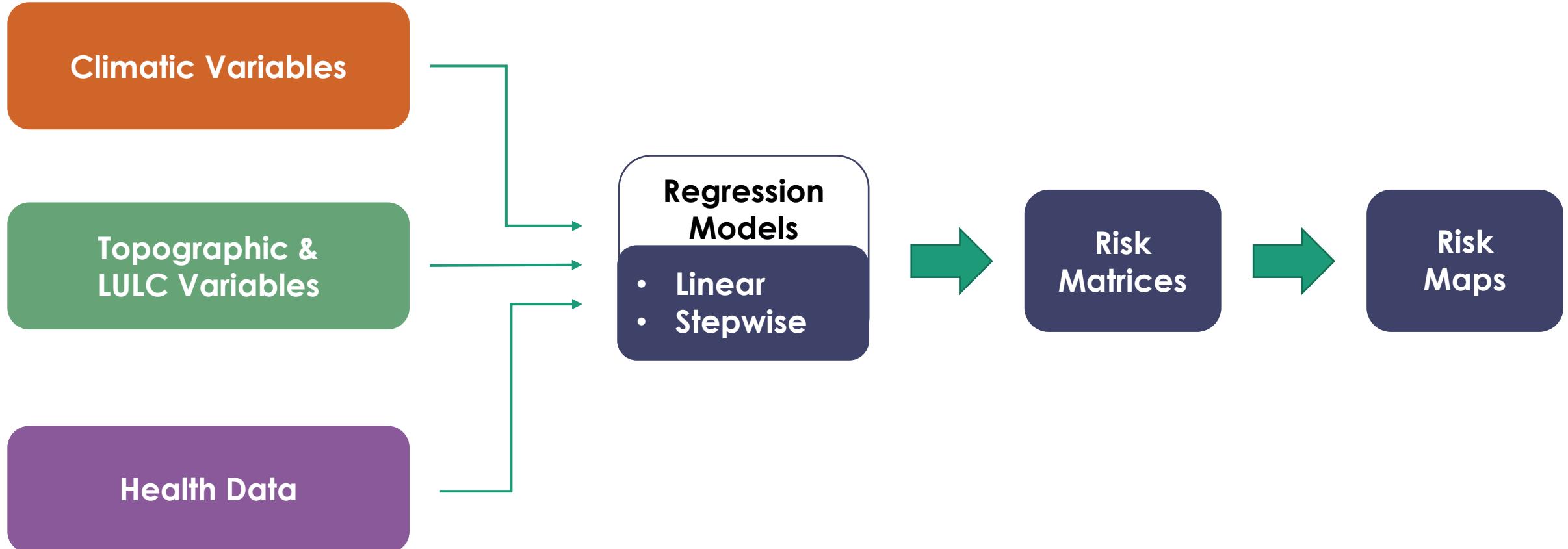


NASA Satellites & Sensors

Satellite & Sensor	Categories	Years
Landsat 5 Thematic Mapper (TM)	Tier 1	2010
Landsat 7 Enhanced Thematic Mapper Plus (ETM+)	Tier 2	2010 - 2014
Landsat 8 Operational Land Imager (OLI)	Level 2 Collection 2 Tier 1	2015 - 2020
Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (IMERG)	Version 6	2010 - 2020
Shuttle Radar Topography Mission (SRTM) Digital Elevation Data	Version 4	2000

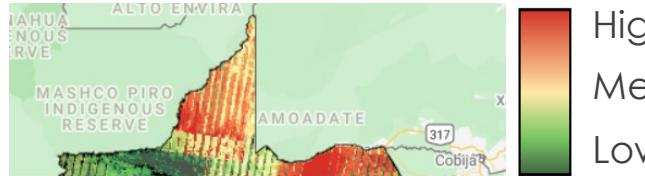


Methodology Overview



Data Processing

Climatic Variables



Temperature



Precipitation

Topographic Variables

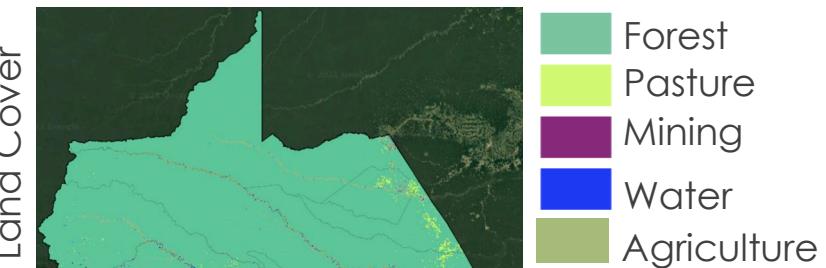


Elevation



Slope

LULC Variables



Land Use Land Cover



Urban-Forest Edge

N
20km

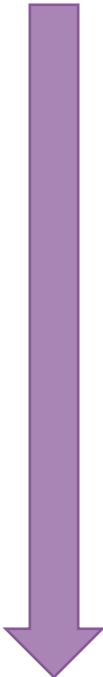


Data Processing

Health Data

Dengue Fever Cases

Leishmaniasis Cases



Filter Weekly Health Post Data (2000-2021)
to 2010 and 2020

Filter To Wet/Dry Season & Full Seasonal Year

Normalize Disease Incidence to District Population

Statistical Analysis

Independent Variables

Temperature

Wet Season

Seasonal Year

Precipitation

Wet Season

Seasonal Year

Elevation

Slope

Urban

Forest

Agriculture & Pastures

Water & Wetlands

Human-Altered Environments

Urban-Edge

Forest-Edge

Urban-Forest Edge

Dependent Variables

Dengue Fever Incidence

Wet Season

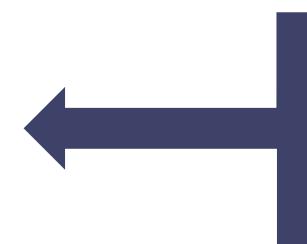
Seasonal Year

Leishmaniasis Incidence

Wet Season

Seasonal Year

Regression Analysis



Regression Results

Dengue
Fever

Urban-Forest
Edge (km^2)



Slope Range

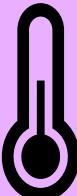


Leishmaniasis

Urban (km^2)



Temperature
Mean



Precipitation
Range



Elevation Mean



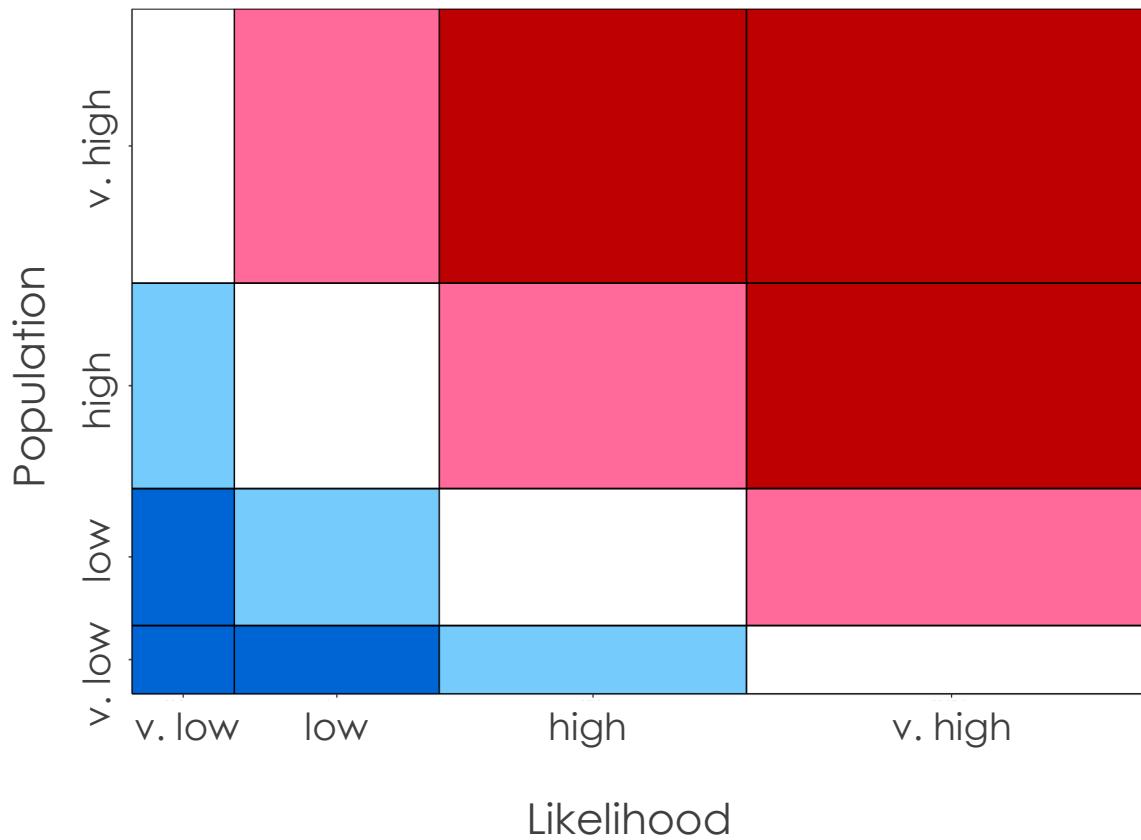


Regression Results

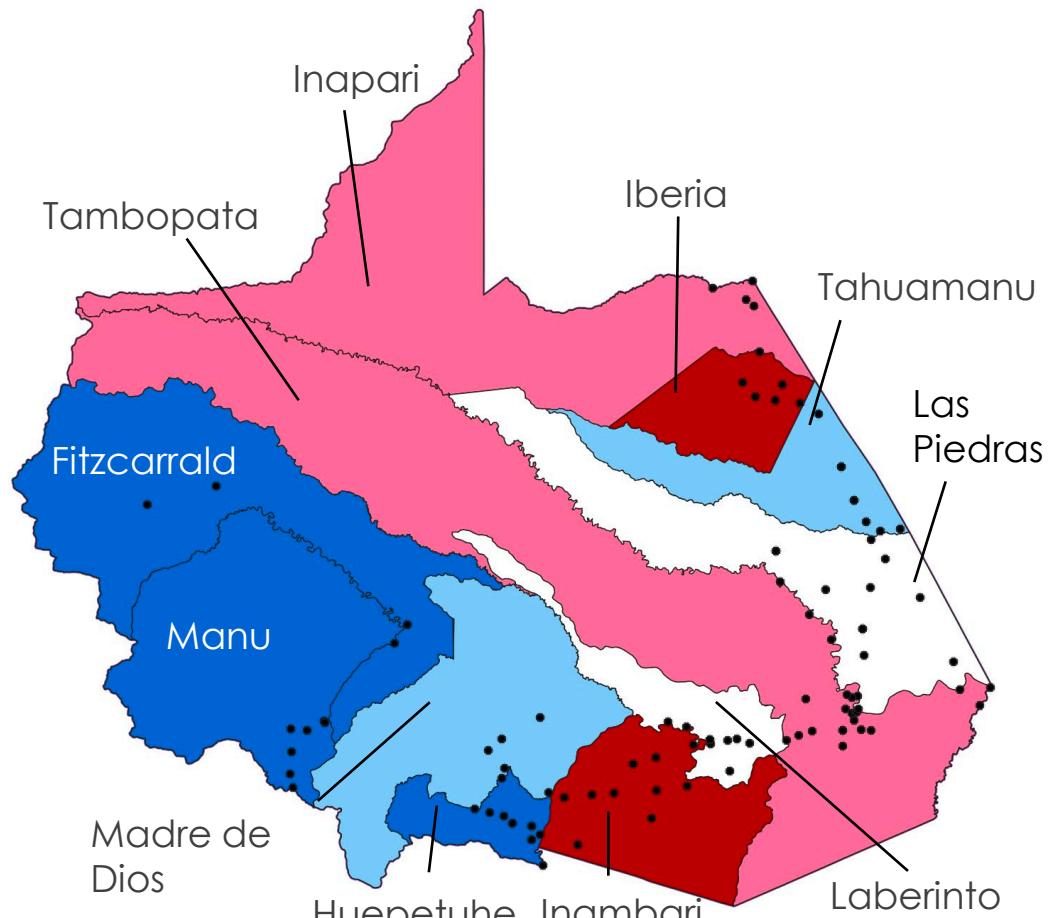
Disease & Date	Variable Combination with the Highest Significance	r ²	p
Dengue: Wet Season 2010	Urban Forest Edge (km ²), Temperature Range, Temperature Median, Slope Range	0.91	6.4 x 10 ⁻⁴
Dengue: Seasonal Year 2010	Urban Forest Edge (km ²), Slope Range, Temperature Mean, Temperature Range, Precipitation Range	0.62	6.8 x 10 ⁻²
Dengue: Wet Season 2020	Urban Forest Edge (km ²), Slope Range	0.48	3.1 x 10 ⁻²
Dengue: Seasonal Year 2020	Urban, Urban Forest Edge(km ²), Slope Range, Temperature Mean, Temperature Range, Precipitation Range	0.73	6.0 x 10 ⁻²
Leishmaniasis: Wet Season 2010	Human-Altered Environments, Forest Edge(km ²), Elevation Mean, Temperature Min	0.89	1.1 x 10 ⁻³
Leishmaniasis: Seasonal Year 2010	Forest Edge (km ²), Elevation Mean	0.80	6.2 x 10 ⁻⁴
Leishmaniasis: Wet Season 2020	Water (km ²), Forest Edge (km ²), Elevation Mean	0.52	4.5 x 10 ⁻²
Leishmaniasis: Seasonal Year 2020	Human-Altered Environment, Urban Edge, Elevation Mean, Temperature Max	0.43	1.2 x 10 ⁻¹



Risk Matrix



Risk Map





Limitations

- ▶ Nuance obscured by low resolution
- ▶ Statistical significance vs. observed transmission patterns
- ▶ Underreporting and understudied



Conclusions

- ▶ Streamlined process to analyze environmental variables contributing to risk
- ▶ Implement Effective Public Health and Land Management Strategies
- ▶ Predictors of Disease Incidence
 - ▶ Dengue: Urban-Forest Edge & Slope Range
 - ▶ Leishmaniasis: Forest-Edge & Elevation Mean



Future Work

- ▶ High resolution PeruSAT-1 imagery
- ▶ Address-level health data
- ▶ Account for population density
- ▶ Additional zoonotic diseases





ACKNOWLEDGEMENTS

DEVELOP

Project Partners

- ▶ **Peruvian Ministry of Health (MINSA)**: Dr. César Munayco
- ▶ **Peruvian Ministry of Environment (MINAM)**: Dr. Tatiana Pequeño, William Augusto Llactayo Leon, Germán Marchand
- ▶ **Lab for EcoHealth and Urban Ecology at La Universidad Peruana Cayetano Heredia**: Dr. Armando Valdes-Vasquez, Ellen Delgado Florian, Vivana Sanchez-Aizcorbe Hennings, Dr. Gabriel Carrasco
- ▶ **El Instituto del Bien Común (IBC)**: Miguel Macedo, Kathrin Hopfgartner, Andrea Bravo
- ▶ **The National Commission for Aerospace Research (CONIDA)**: Dr. Jose Pasapera Gonzales
- ▶ **La Asociación para la Conservación de la Cuenca Amazónica (ACCA)**: Sidney Novoa

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- ▶ Dr. Marguerite Madden (University of Georgia - Athens)
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