GeoHealth: A Surveillance and Response System Resource for Vector Borne Disease in the Americas

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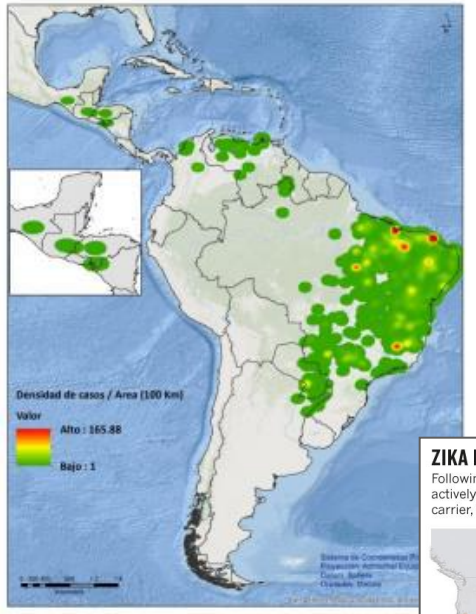
Objectives

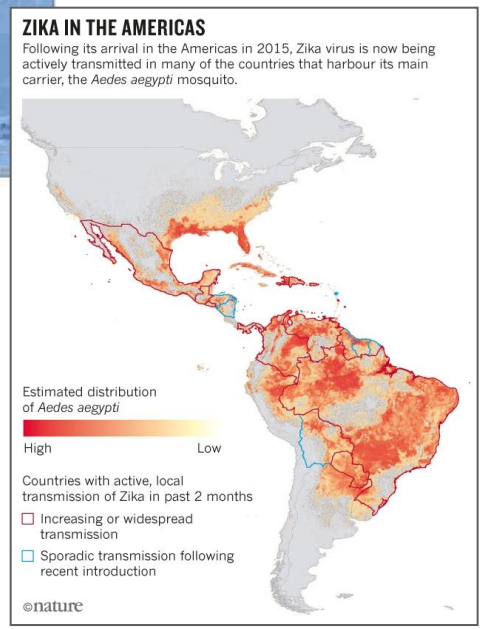
- Construct a geospatial health resource data portal (GeoHealth) compatible with GEOSS

- Map and model the epidemiological risk of two prototype vector borne diseases: Visceral leishmaniasis and *Aedes* borne arboviruses

- Process big data to discover ‘hidden’ associations of disease for ecological niche modeling vs hypothesis-driven statistical analysis

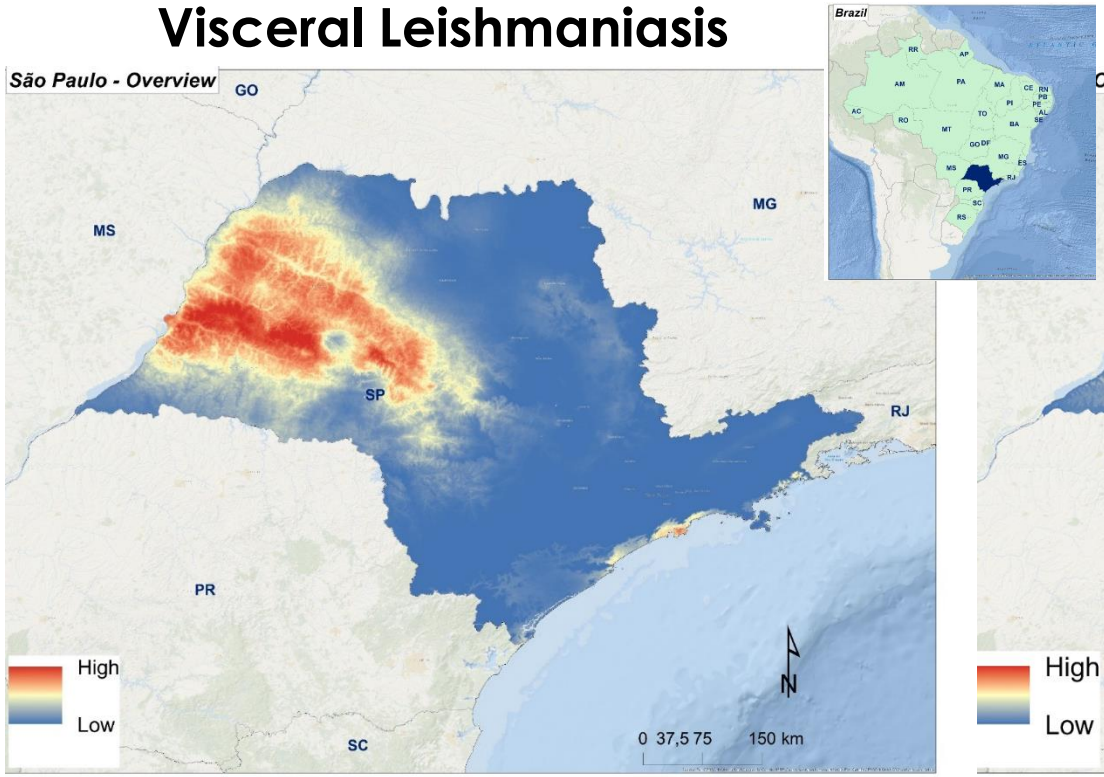
- Implement dissemination and training programs to promote geospatial mapping and modeling for VBD as envisioned in GEOSS.





WorldClim 2.0

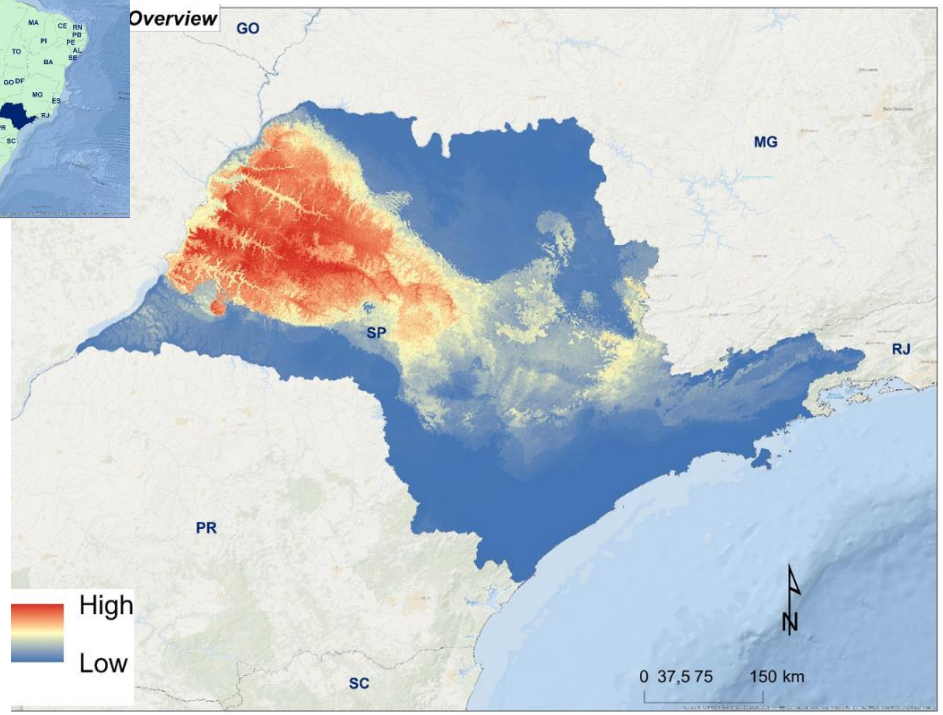
Visceral Leishmaniasis



AUC VL Worldclim – 0.882
Tmax12 35.7%
Prec06 19.7%
Tmax01 13.9%

BioClim

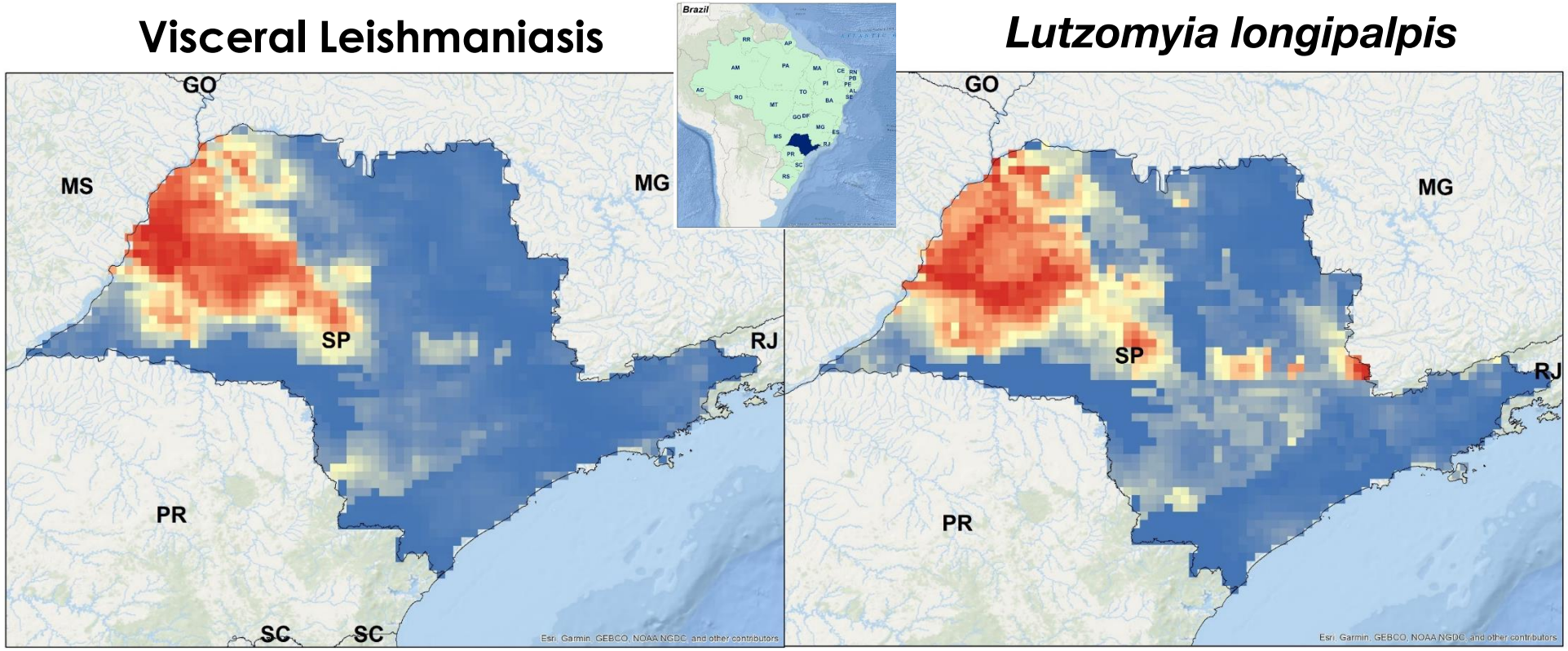
Lutzomyia longipalpis



AUC LL BioClim – 0.835
Bio 14 21.3% - Prec Driest Mo
Bio 15 13.8% - Prec Seasonality
Bio 16 16.9% - Prec Wettest Q

Results suggest *Direct* earth observing satellite measurement of soil moisture by SMAP can be used *in lieu* of models calculated from classical thermal and precipitation climate station data to assess VL disease risk and to guide control program interventions.

Visceral Leishmaniasis



AUC VL SMAP – 0.884

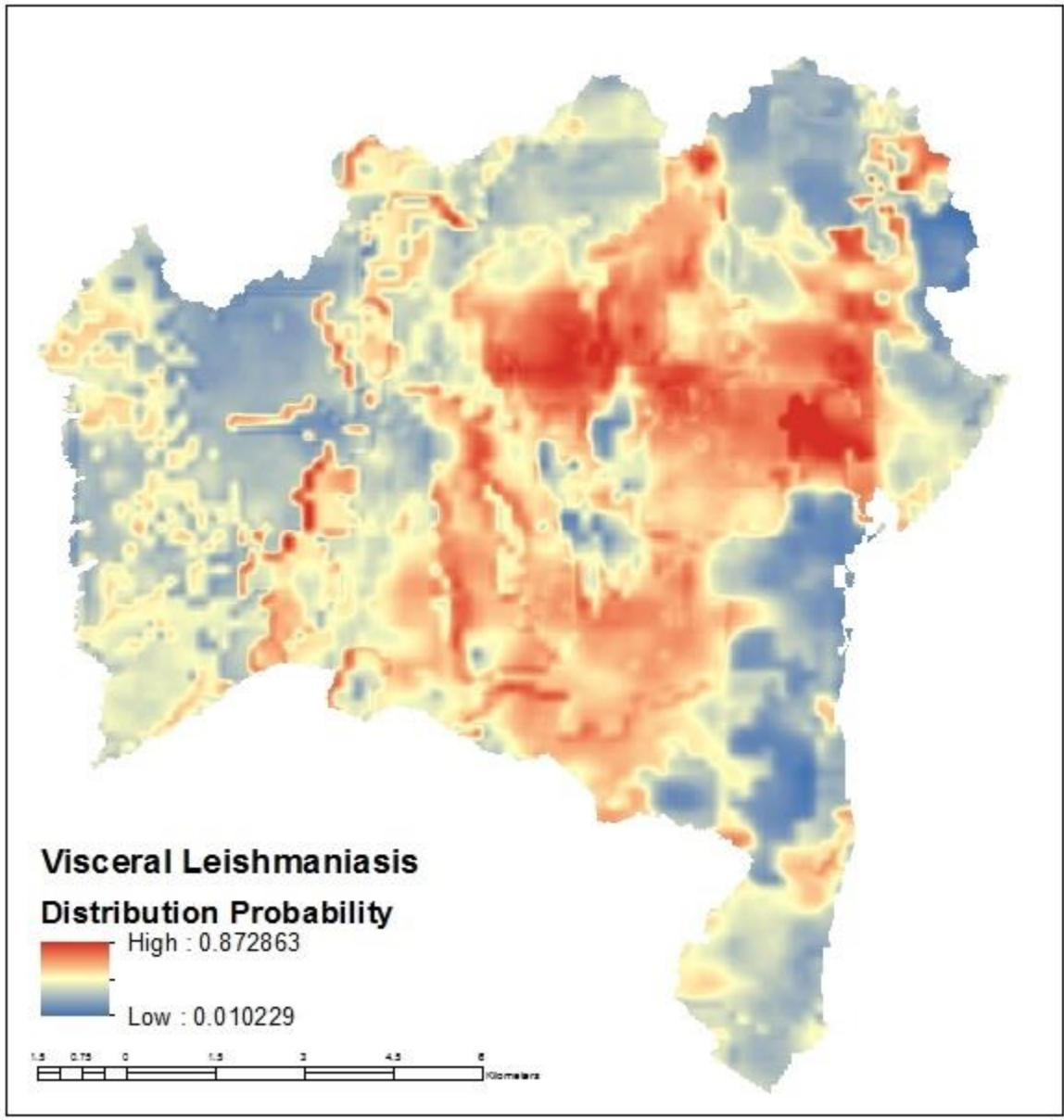
Oct	27.1%
Aug	24.8%
Sept	20.4%

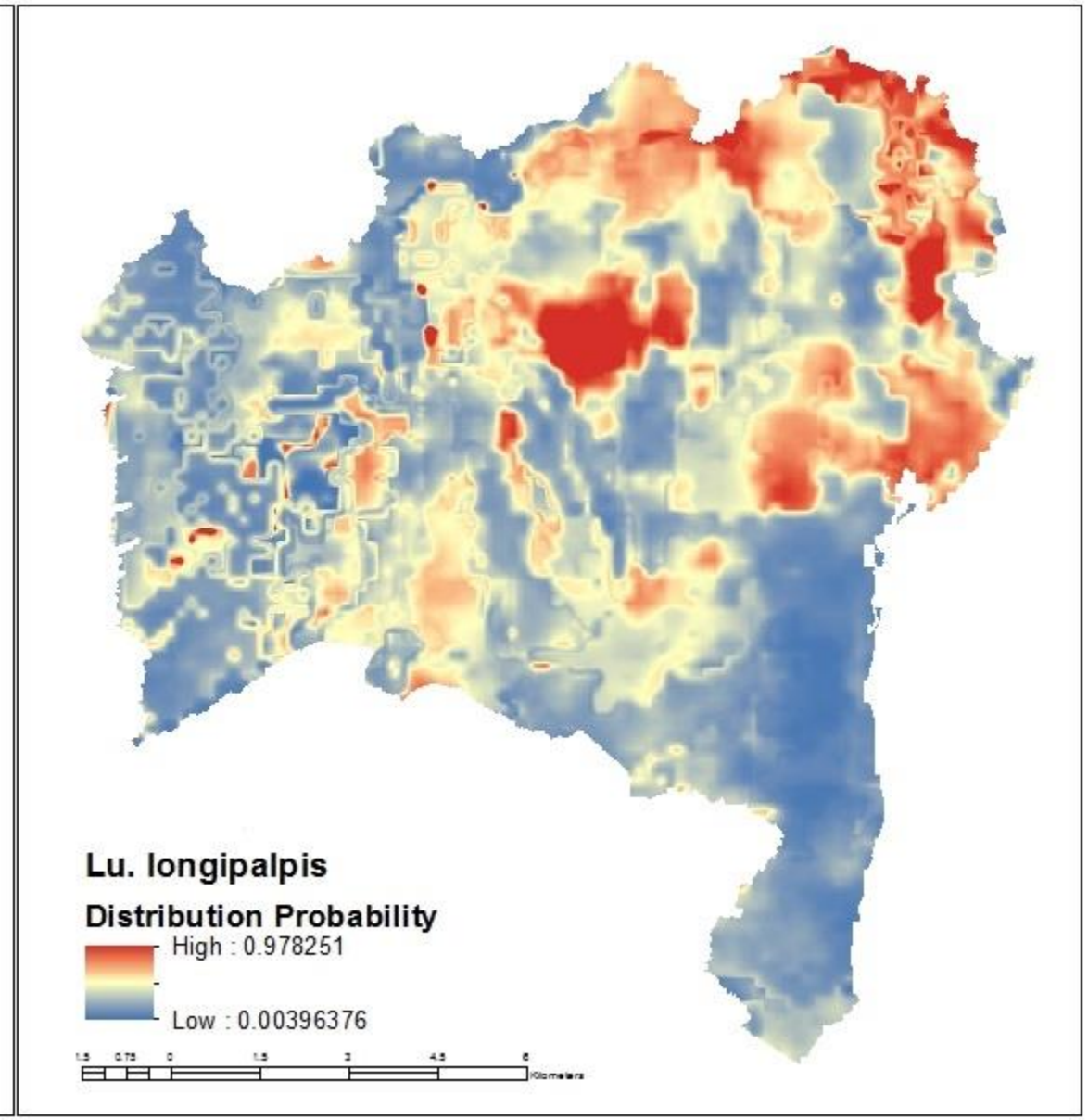
Lutzomyia longipalpis

AUC LL SMAP – 0.793

July	37.4%
Dec	17.0%
March	14.5%

SMAP 1Km Maxent Models





Surveillance and Response Systems for Visceral Leishmaniasis

Global 1km Scale

WorldClim 2 Models
30-Year Climate Station Data

Tmax/Tmin/Prec →
Water Budget (Prec/PET)

Biology-Based GDD-WB Generations/year

Satellite Climatology Models
2017- 2019 Data

*__VIIRS__-8d LST
*__GPM__ →
*__SMAP__
__GOES-16__

Community/Agricultural Field Scale (30m)

*__Landsat 8__; Landsat Legacy
*__ASTER__
*__ECOSTRESS__

Habitat-Household Scale (<1m)

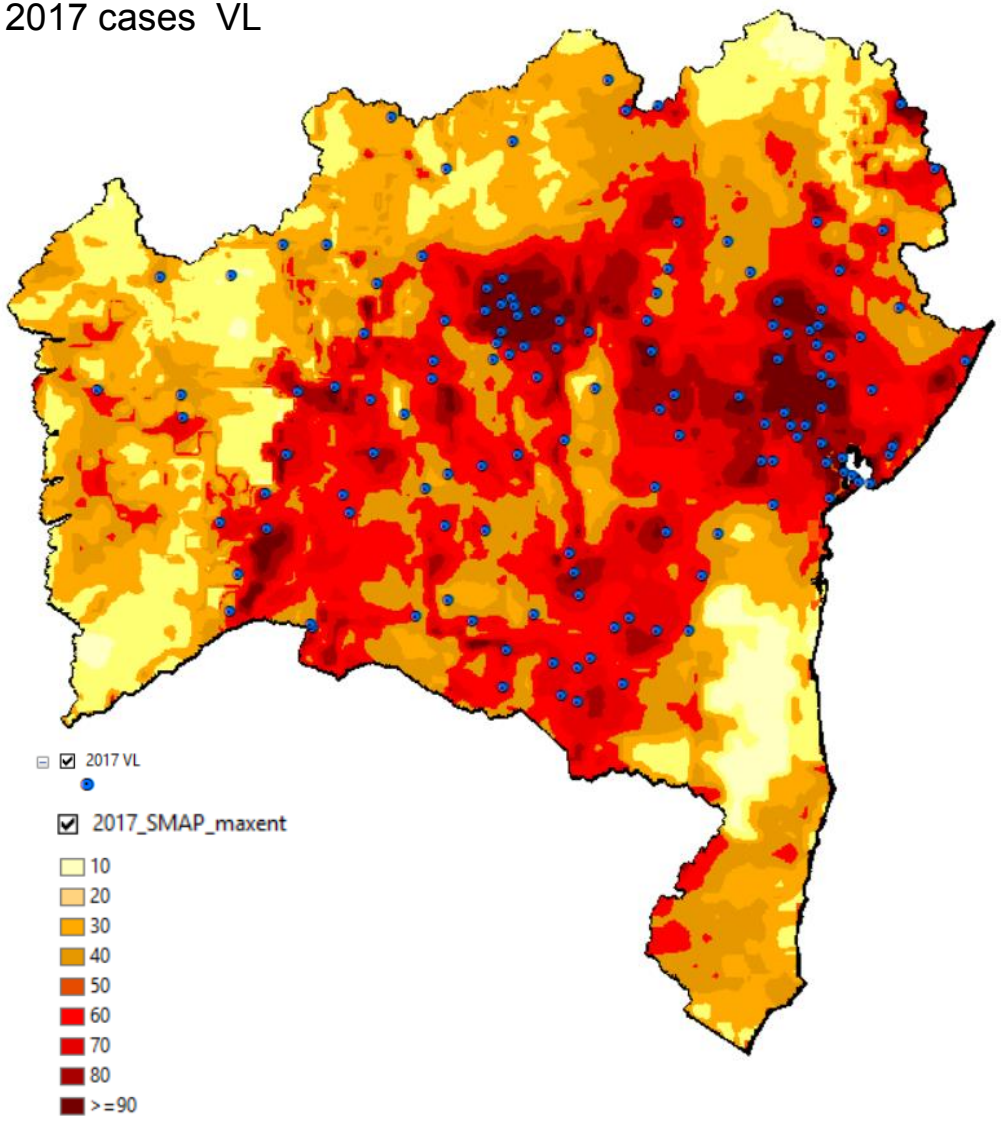
(Household = Epidemiologic Unit)

*__Worldview__ 2,3
*__GeoEye__

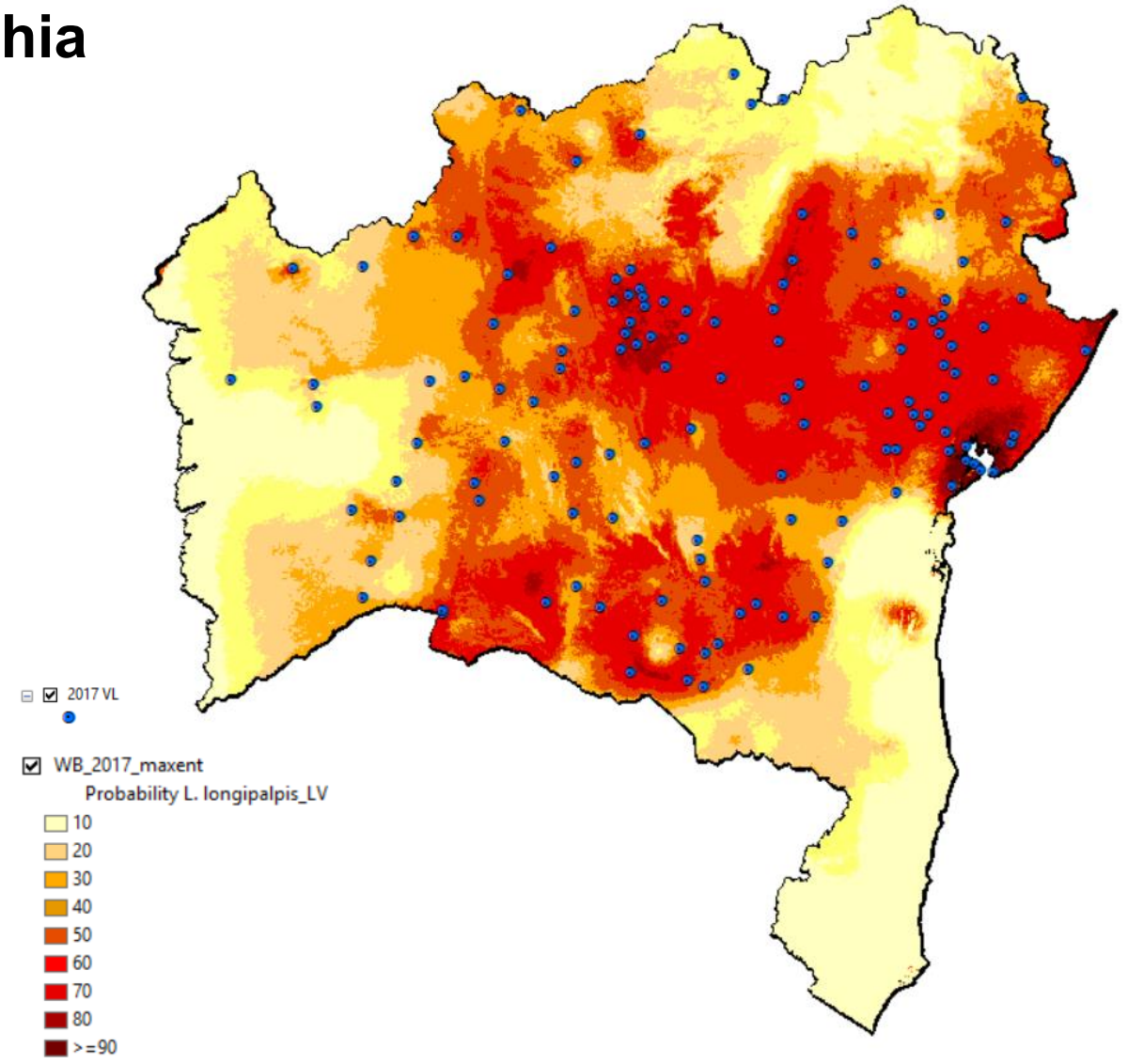
Lutzomyia longipalpis **Gen/yr**
Base temperature = 16
GDD one generation = 414
WB = ≤0.8
(**Nieto et al., 2006**)

2017 - VL cases Bahia

SMAP Maxent- BA
2017 cases VL

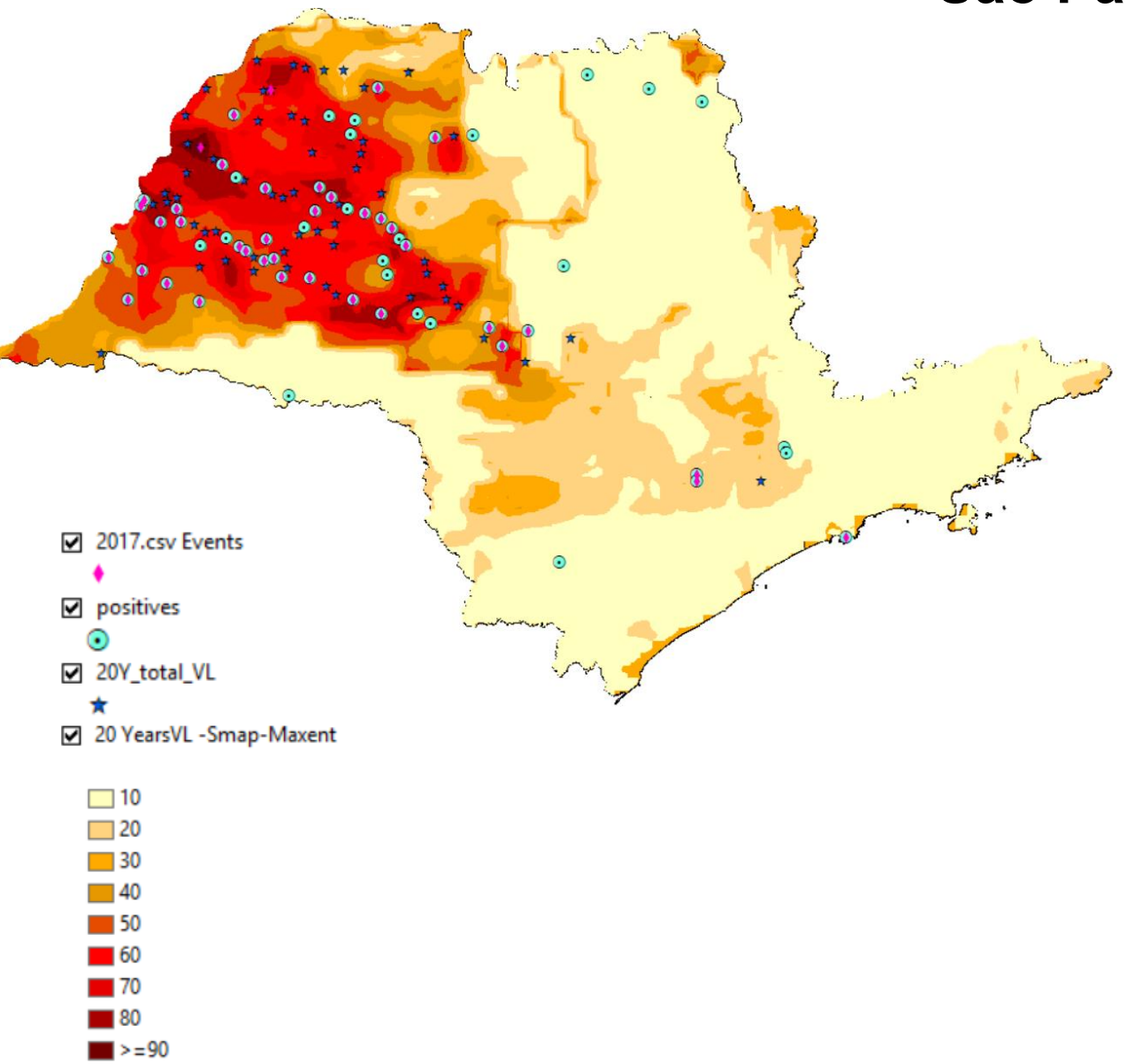


WB Maxent- BA
2017 cases VL

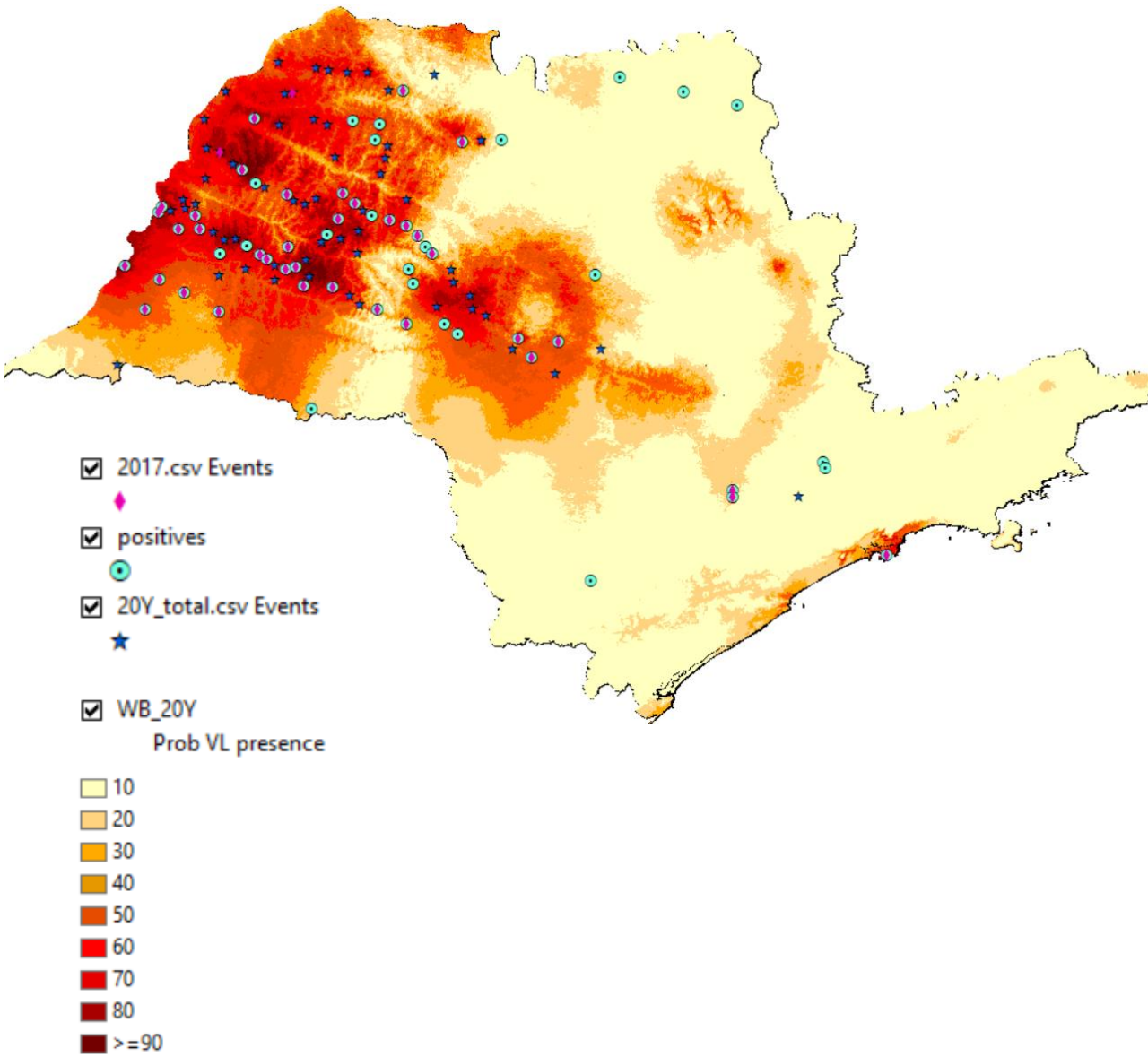


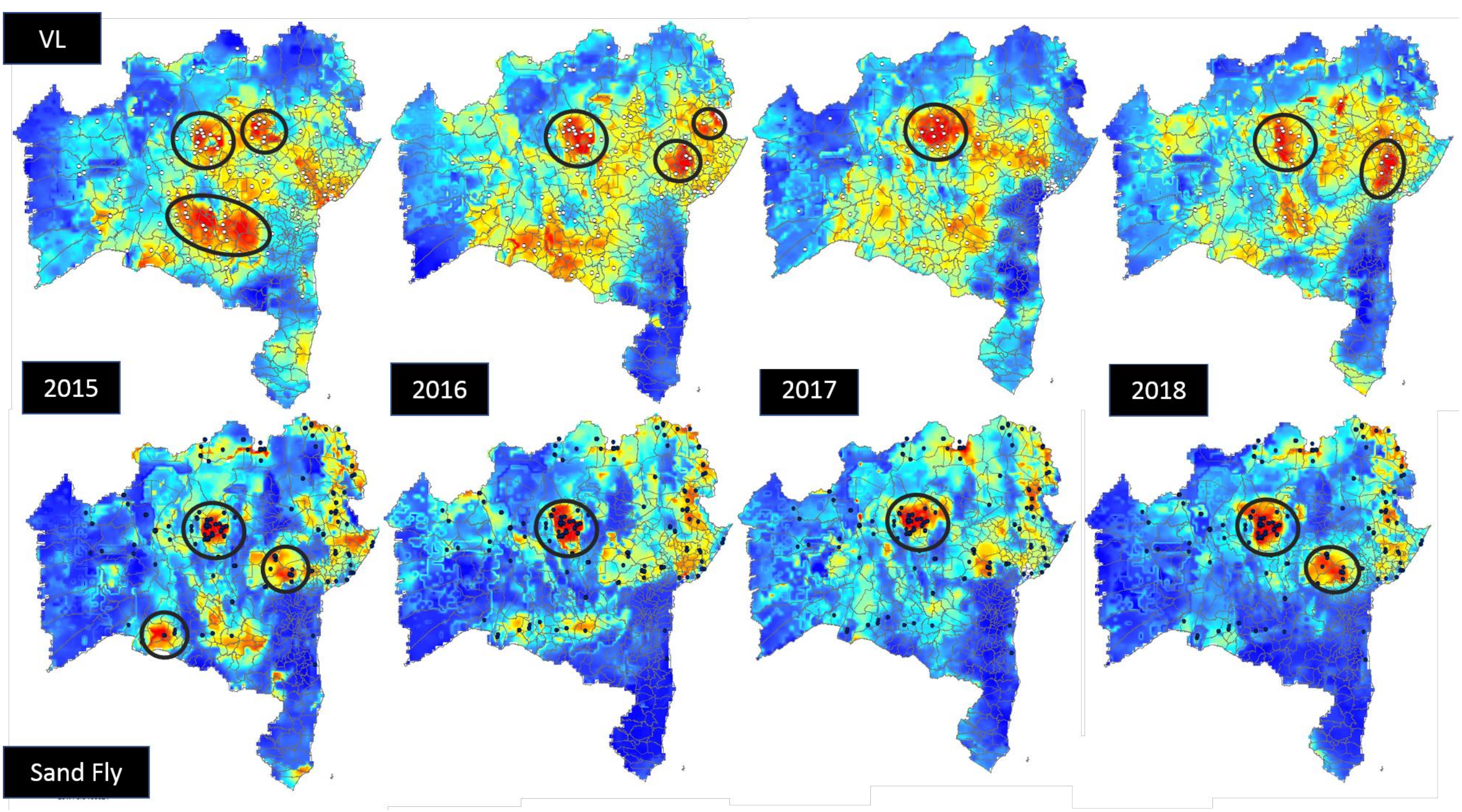
Incidence VL São Paulo

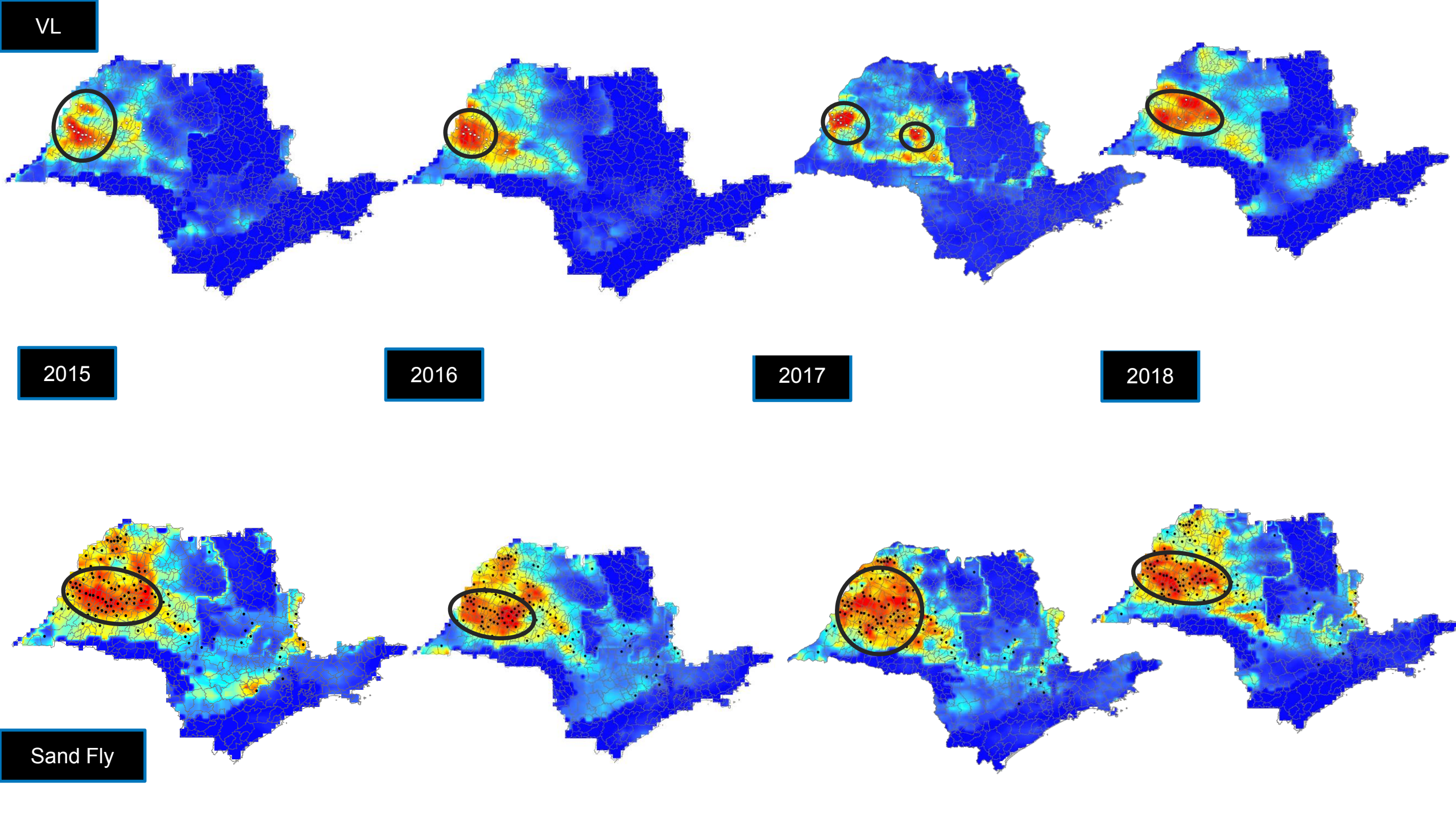
SMAP SP Maxent
20 years Incidence VL



WB SP Maxent
20 years Incidence VL




VL
2015
2016
2017
2018
Sand Fly


VL
2015
2016
2017
2018
Sand Fly

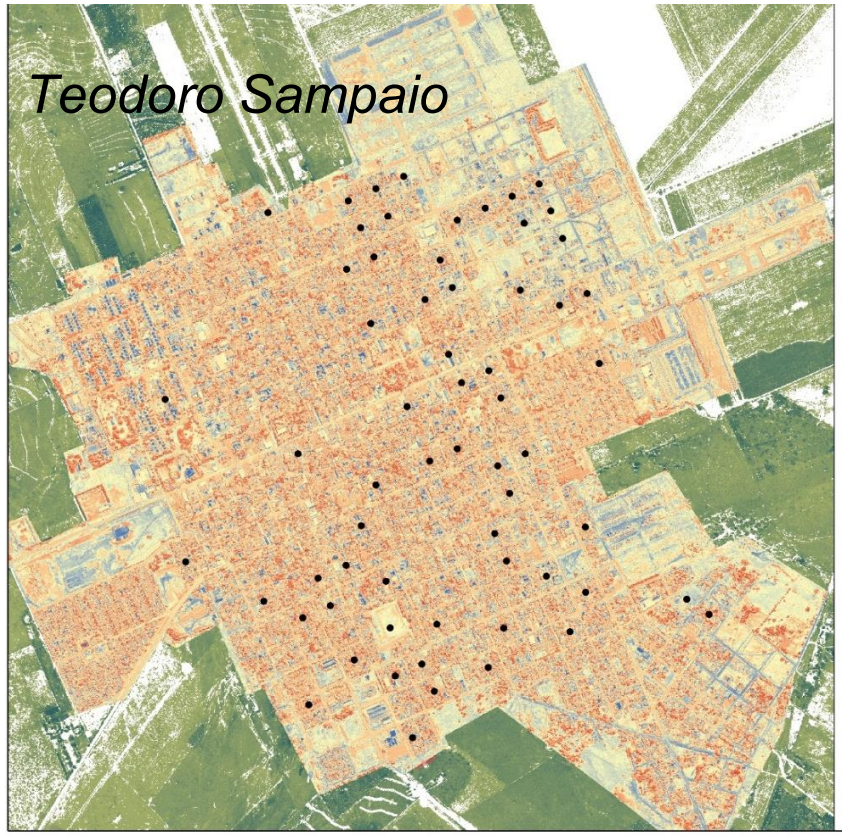
Maxent Models SMAP VL Cases

SMAP	Years	AUC	%Contribution	Jackknife test (Highest gain)	Jackknife test (Decreases gain)
VL BA	2015	0.85	SMAP 12 (44.2)	SMAP 04	SMAP 04
	2016	0.859	SMAP 01 (28.3)	SMAP 01	SMAP 01
	2017	0.828	SMAP 09 (34.1)	SMAP 09	SMAP 06
	2018	0.869	SMAP 01 (27.1)	SMAP 01	SMAP 05
VL SP	2015	0.869	SMAP 06 (29.3)	SMAP 08	SMAP 07
	2016	0.959	SMAP 11 (37.1)	SMAP 11	SMAP 11
	2017	0.945	SMAP 07 (49.1)	SMAP 09	SMAP 07
	2018	0.928	SMAP 06 (66.1)	SMAP 06	SMAP 06

Maxent Models SMAP Sand Fly

SMAP	Years	AUC	%Contribution	Jackknife test (Highest gain)	(Decrease gain)
SF BA	2015	0.85	SMAP 12 (44.2)	SMAP 12	SMAP 12
	2016	0.859	SMAP 11 (31.9)	SMAP 11	SMAP 01
	2017	0.828	SMAP 02 (20.8)	SMAP 02	SMAP 11
	2018	0.869	SMAP 01 (32)	SMAP 01	SMAP 12
SF SP	2015	0.869	SMAP 06 (29.3)	SMAP 08	SMAP 07
	2016	0.874	SMAP 11 (29.6)	SMAP 11	SMAP 11
	2017	0.878	SMAP 07 (27.2)	SMAP 06	SMAP 07
	2018	0.878	SMAP 06 (45.5)	SMAP 09	SMAP 02

Models - Habitat-Household level



NDVI

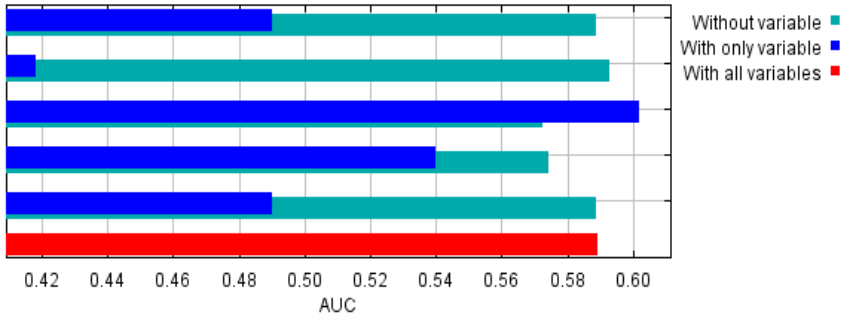
NDWI

Mud Index

NHFD

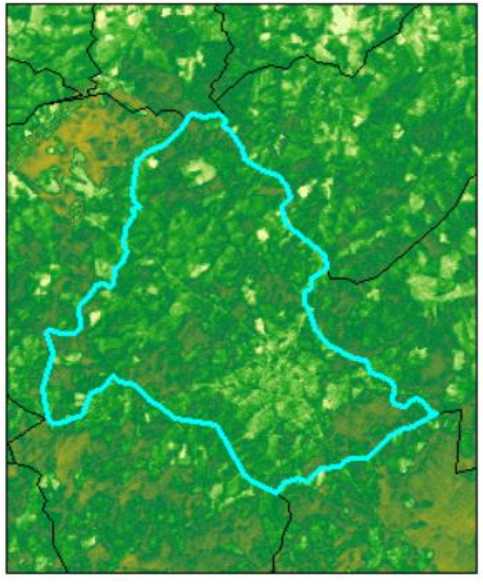
Build up index

Built up index
Mud Index
NDVI
NDWI
NHFD



Biological Drivers and Limiting Factors

Collaborators
Adolfo Lutz Institute, Sao Paulo
UNESP Presidente Prudente-Geography



ECOSTRESS IMAGE CATALOG

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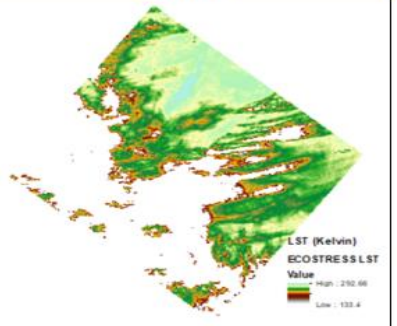
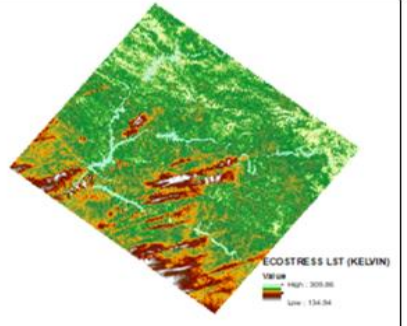
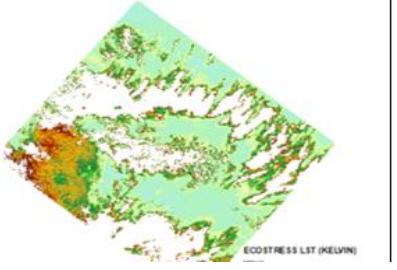
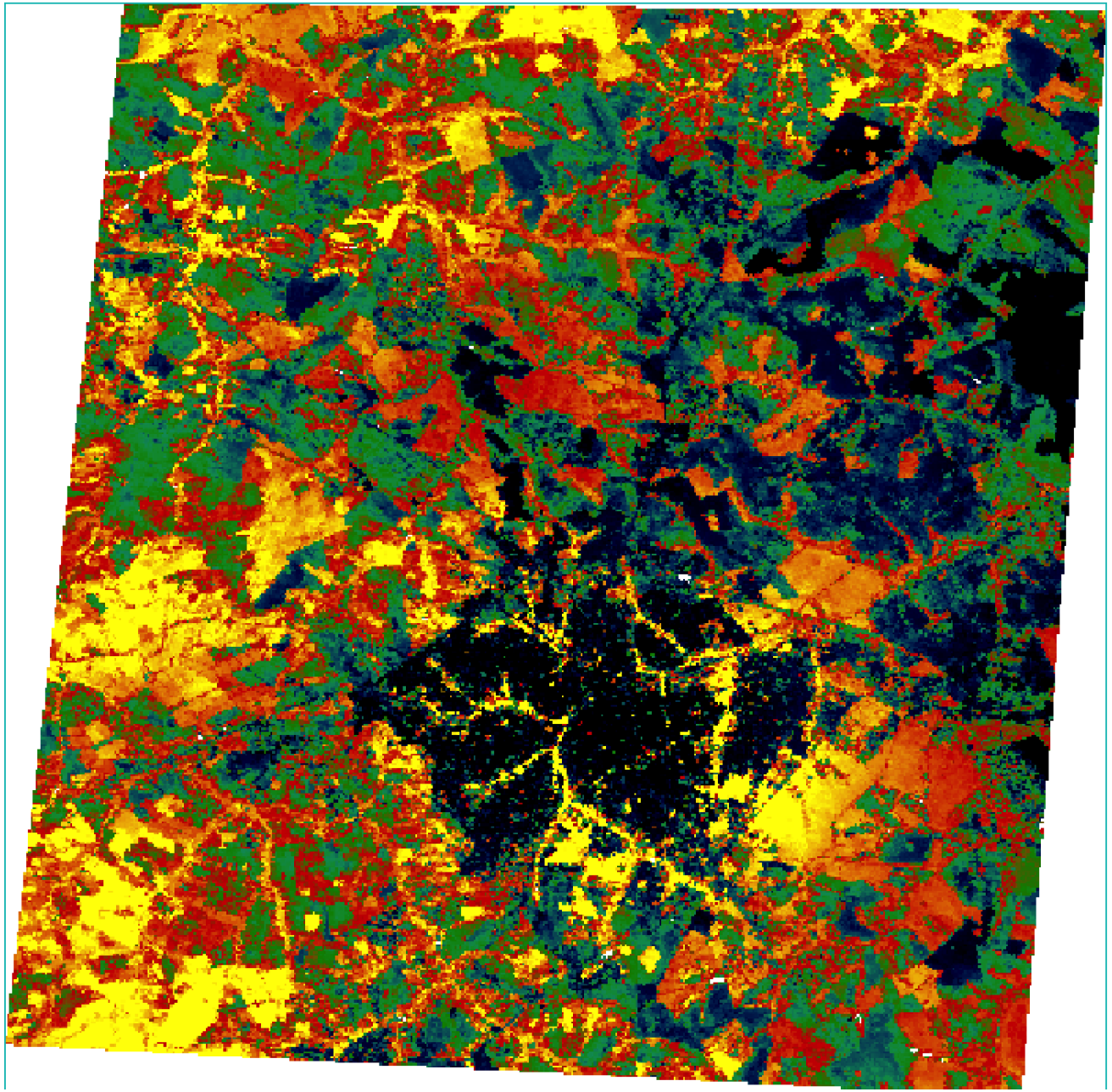
ECOSTRESS_L2_LSTE_00616_005_ 20180815T100949_0501_02_LST_UTM.tif	August 15, 2018 7:09:49 AM		
ECOSTRESS_L2_LSTE_00616_006_ 20180815T101041_0501_02_LST_UTM.tif	August 15, 2018 7:10:41 AM		
ECOSTRESS_L2_LSTE_00723_005_ 20180822T071955_0501_02_LST_UTM.tif	August 22, 2018 4:19:55 AM		



Bauru Daily ET wm-2

2018 Day 256

ECOSTRESS 70m res.

Min
196 wm-2

Max
370 wm-2

Mean
294 wm-2

SUMMARY

BAHIA STATE
Human cases of VL: SMAP January (most important variable), SMAP April and SMAP September
Sand fly: SMAP December (most important variable), SMAP November and SMAP January (for the sand fly model in Bahia, it was possible to observe a seasonality for SMAP that encompasses the period between December to February)

SAO PAULO STATE
Human Cases of VL: SMAP June (most important variable), SMAP July and SMAP November
Sand fly: SMAP of June, July and November (most important variables)

2016 showed identical behavior for both states considering SMAP data, with the most important variable being SMAP of November for both states

Neural Network Models

DISEASE Data

- Disease data per month (12) * (3 years) and
- Disease data per season (moving 3 month average) 12 each year *(3 years).
- (point* and polygon 1Km)

SMAP IMAGES

- SMAP data 2 per mo (24) * (3 years)=72 images
- SMAP per season (moving 3 month average)= 24 per year * (3 years)=72 images
- 10 km and resampled 1km resolution
- If each 3 day, 10/mo) x 36 = 360 images

AnPG VIIRS/GPM Images

- AnPG (per month (12) * (3 years)= 36 images
  AnPG per season (moving 3 month average)= 12 per year *(3 years)=36 images
- 1km resolution
- If/ea 8day = 48 x 3 yr=144 images AnPG

- Disease points
- SMAP images
- AnPG images

- 12 months
- Seasonal (moving 3 mo avg)
- 3 years **

= **96 Images and Disease data → **Neural Network Models**

**This number will increase as we get more than 3 years of data and/or if we use bimodal seasonality .