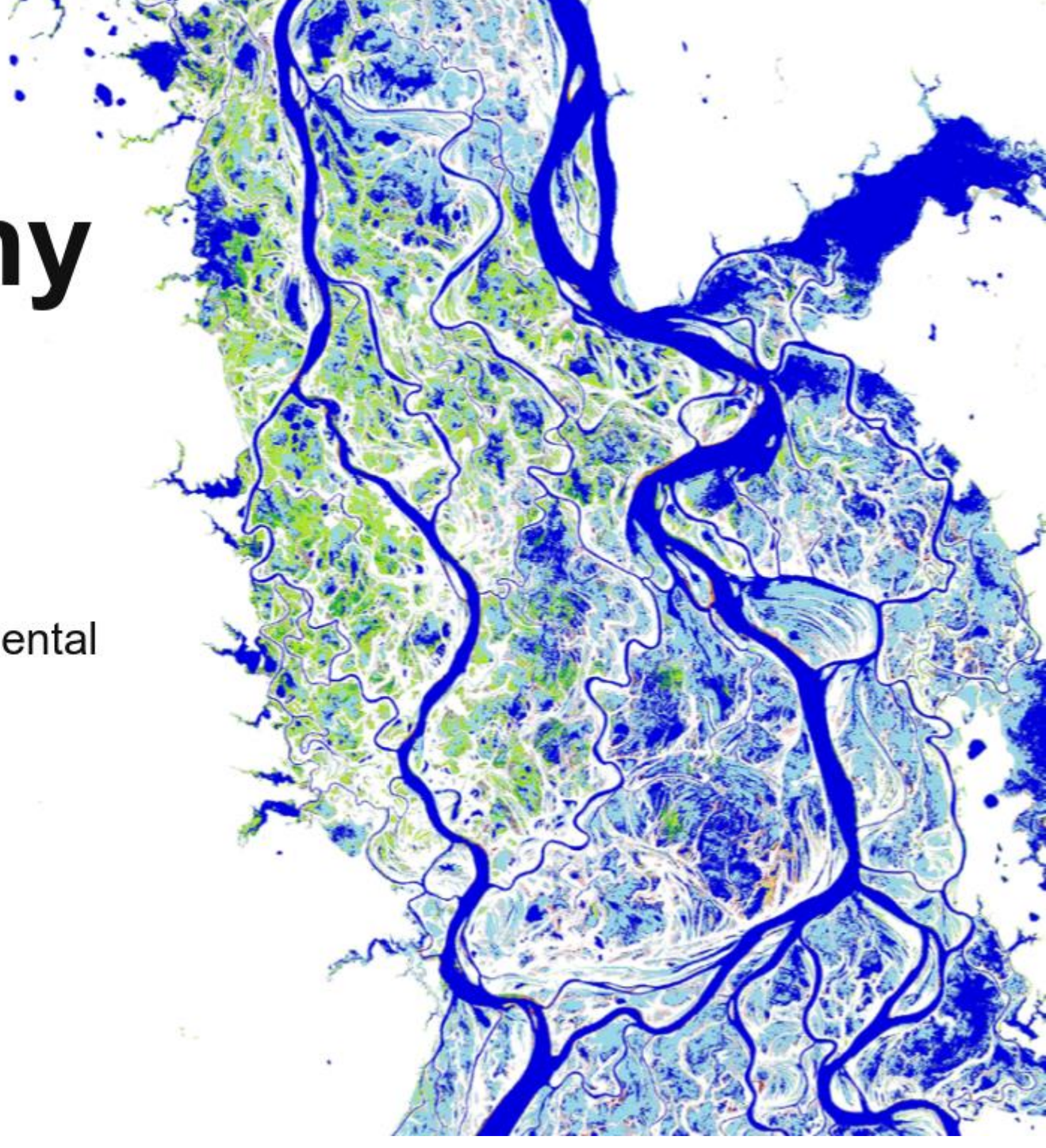
Health Geography

Data and tools to integrate climate and environmental information into health surveillance system.

Florian Girond



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Institut Pasteur du Cambodge

Malaria Early Warning System Madagascar (2012 - 2016)

using a sentinel surveillance system

Malaria surveillance web tools (2019 -...)

Schoclo malaria reasearch unit (SMRU)

Malaria Early Warning System Madagascar (2012 - 2016)

using a sentinel surveillance system

Malaria surveillance web tools (2019 -...)

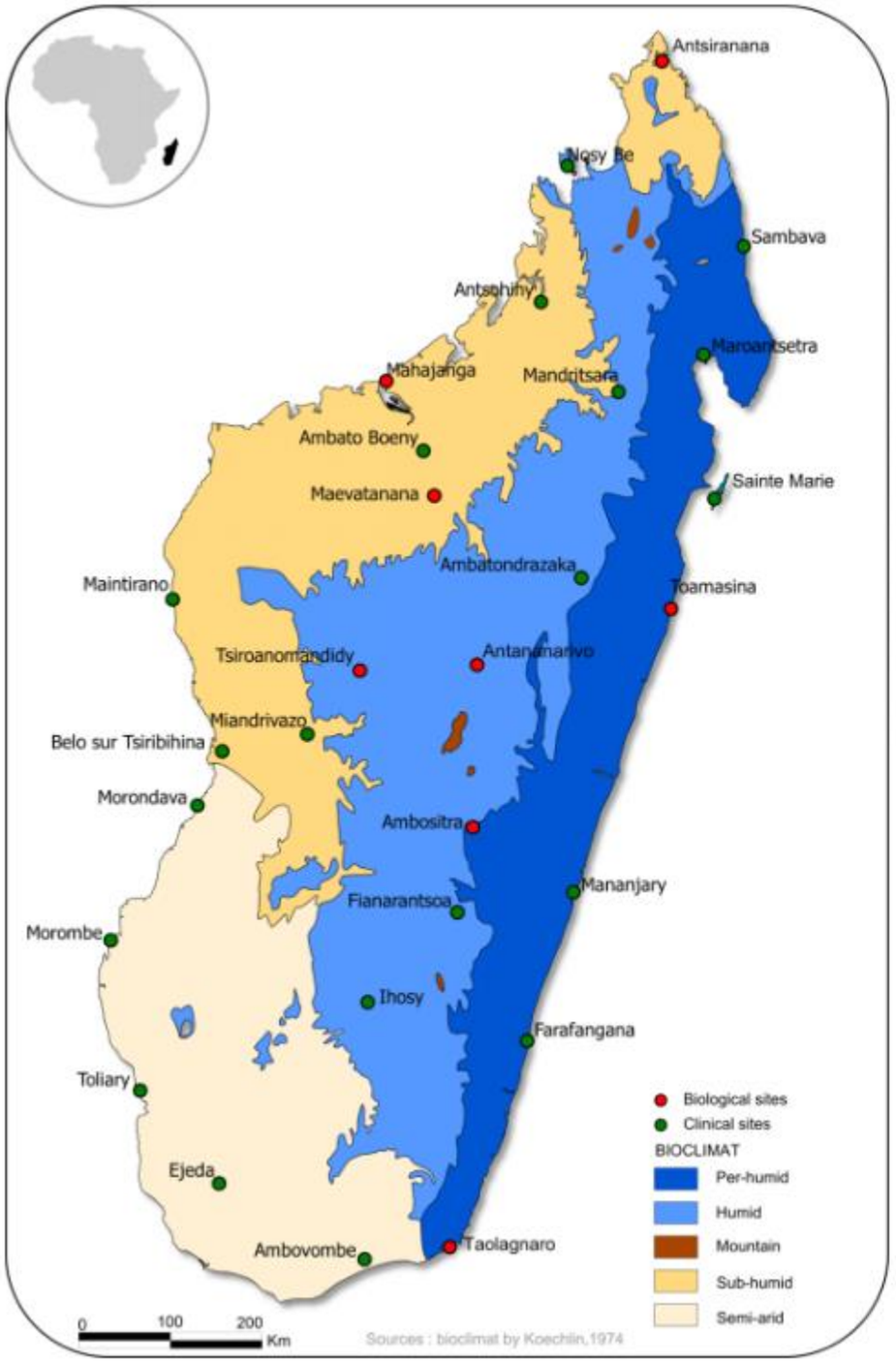
Schoclo malaria reasearch unit (SMRU)

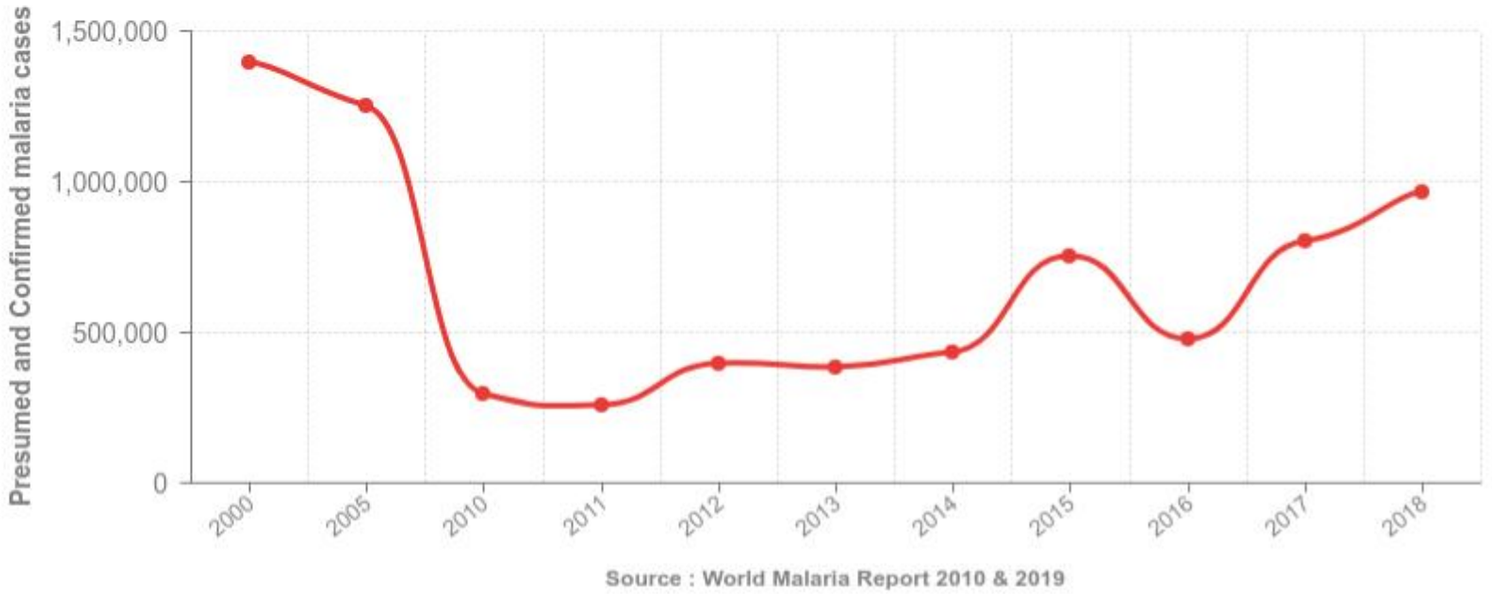
Sentinel Surveillance System

Institut Pasteur de Madagascar

In 2012, the only way to get near real time quality data on malaria in Madagascar.

- 34 sentinel sites
- Weekly data





Sentinel sites notifications

Weather and environmental data

LLINs IRS

SMS

CSV

Automatic feedback report

SMS

Automatic trends analysis and epidemics detection

Interactive web based interface

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Surveillance Sentinelle Madagascar (beta)

Institut Pasteur de Madagascar

Alert Thresholds

Algorithms:

- (•) Percentile
- ( ) MinSan
- ( ) C-SUM
- ( ) RDT+/fever Indicator

About algorithm

An alert is triggered when a week malaria cases exceeds selected value (below) of percentile of the whole chronological series of a site. The 90th percentile is the value such that 90% of the time series values are below it (and therefore 10% are above).

Centile Value:

1 — 90 — 100

1 11 21 31 41 51 61 71 81 91 100

This option is intended to improve the specificity of the alert system

Number of consecutive weeks above threshold:

- ( ) 1
- ( ) 2
- (•) 3
- ( ) 4

Map | Graph | Level_Plot | Forecasting

Circle width is proportional to percentile value (click on map and see below)

The number of reported malaria cases is below the threshold

The number of reported malaria cases is above the threshold

Click on a site to see malaria time series

Week : 2017_22

Click on the legend to hide/show variables

Click and drag on the graph to zoom

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Institut Pasteur de Madagascar

Alert Thresholds

Algorithms:

- Malaria cases
- MinSan
- Percentile
- C-SUM
- RDT+/fever indicator

Please select data aggregation level (by facies)

National

Centile Value:

1 — 90 — 100

This option is intended to improve the specificity of the alert system

Number of consecutive weeks above threshold:

- 1
- 2
- 3
- 4

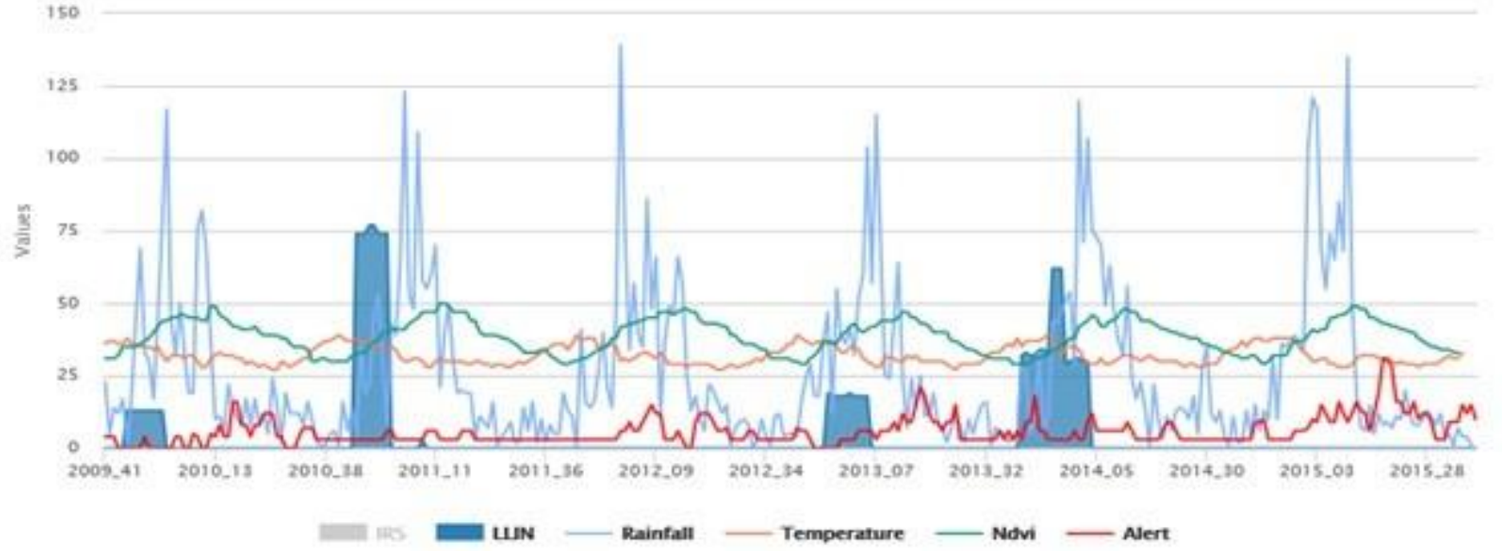
Number of years to display:

1 — 6 — 7

An alert is triggered when a week malaria cases exceeds selected value (below) of percentile of the whole chronological series of a site. The 90th percentile is the value such that 90% of the time series values are below it (and therefore 10% are above)

Map | Graph | Level_Plot | Forecasting

Percentile



Click on the legend to hide/show variables

Click and drag on the graph to zoom

Legend

Alert, is proportion of site in alert across selected facies in the side panel.

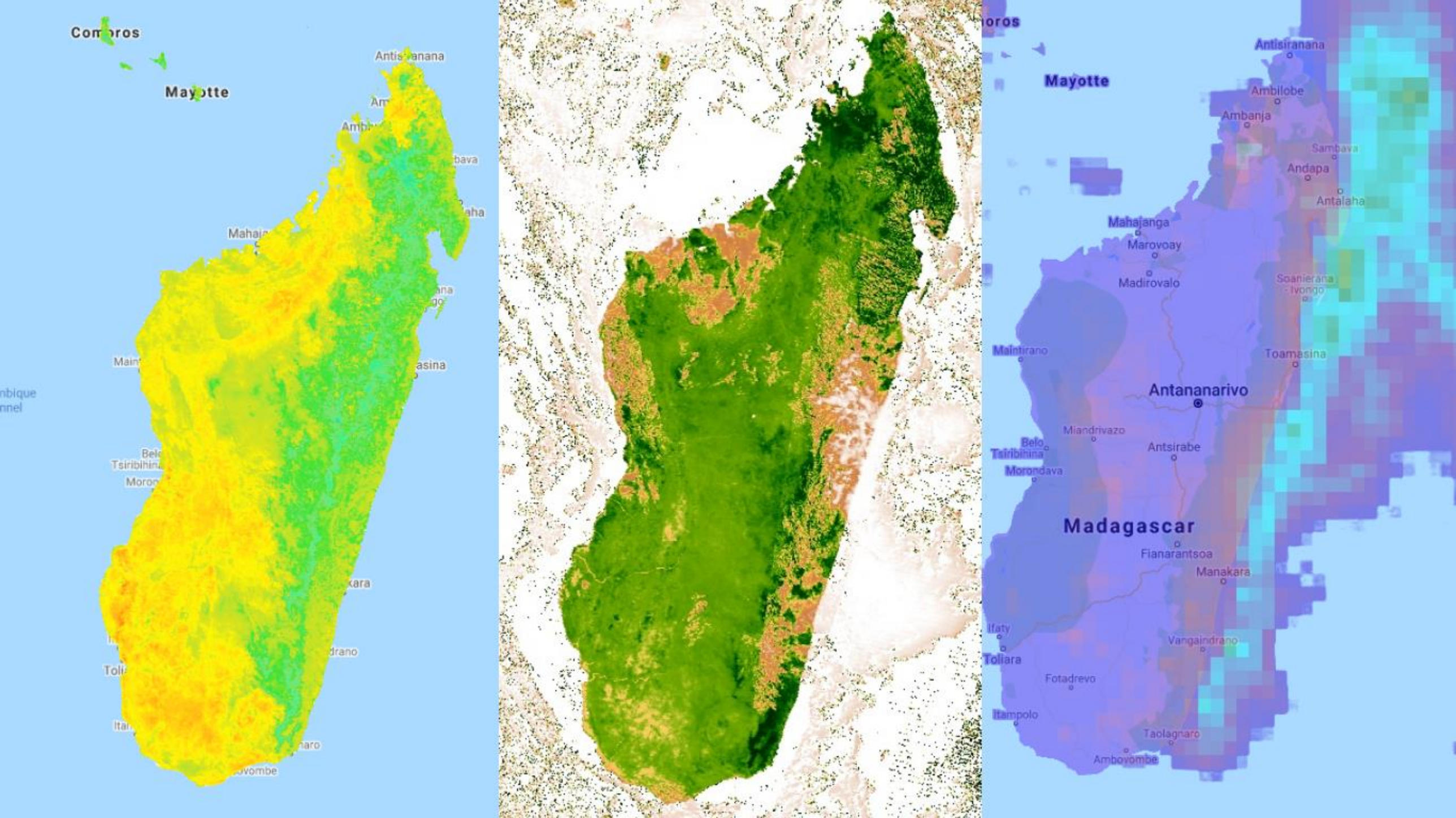
Rainfall, African Rainfall Estimation (RFE) is produced by NOAA-CPC

NDVI, is a normalized difference vegetation index (NDVI) produced by MODIS

Temperature, Land Surface temperature is an estimation of near surface temperature, produced by MODIS

IRS, proportion of sites that received a IRS

LLIN, proportion of sites that received a LLIN

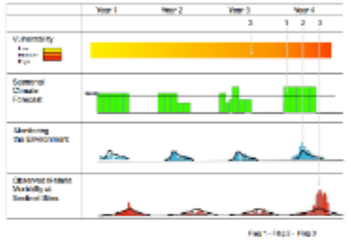

Comoros
Mayotte
Antsiranana
Ambilobe
Ambanja
Sambava
Andapa
Antalaha
Mahajanga
Marovoay
Madirovalo
Soanierana - Ivongo
Maintirano
Toamasina
Antananarivo
Miandrivazo
Belo Tsiribihina
Antsirabe
Morondava
Madagascar
Fianarantsoa
Manakara
Ifaty
Vangaindrano
Toliara
Fotadrevo
Itampolo
Taolagnaro
Ambovombe

Climate and Health | Climate and Malaria | Climate and Malaria | Malaria Early Warning System

Malaria Early Warning System

The Malaria Early Warning System (MEWS) aids in the prediction of malaria outbreaks. The system consists of four elements; Vulnerability, Seasonal Climate Forecasts, Monitoring the Environment and Observed Malaria Morbidity. In certain regions, these products may be used to determine the timing and severity of an outbreak.

This maproom outlines each element of the MEWS. Each element contains products, some of which may be used to help determine the risk of a malaria outbreak in a specific region.



Using all of the elements as a system may be useful in understanding the socioeconomic and climatic drivers of malaria in particular regions. The diagram above depicts how the four elements can be employed on different time scales using flags to raise concern of a potential outbreak.

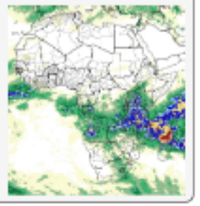
Climatic and environmental variables can indicate an increased risk in vector (mosquito) and malaria parasite development (when inside its mosquito host). Examples of such indicators include precipitation, temperature, humidity and surface water. The Seasonal Climate Forecasts can predict likely changes in climatic and environmental risk several months in advance

Vulnerability | Seasonal Climate Forecast | Monitoring The Environment | Observed Malaria Morbidity

Monitoring The Environment

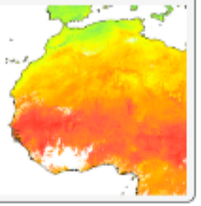
Dekadal (10-day) Precipitation

This map shows dekadal (10-day) precipitation estimates from the Climate Prediction Center.



Inferred Maximum Air Temperature

This map shows approximated maximum air temperatures at 2 meters above the ground.



Precipitation Estimate Differences

This map shows dekadal (10-day) precipitation estimates as the difference from the short term average (from 2000 to last recent complete year).

Measures of Vegetation

This tool produces maps of estimated vegetation using data from NASA's MODIS sensor.

Precipitation Estimate Percentages

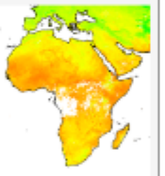
This map shows dekadal (10-day) precipitation estimates as a percentage of the short term average (from 2000 to last complete year).

Vectorial Capacity

This map shows a Vectorial Capacity (VCAP) model that defines precipitation and temperature as the limiting factors of malaria incidence. VCAP is the daily rate at which future malaria inoculations could arise from a currently infected case.

Minimum Land Surface Temperature (LST)

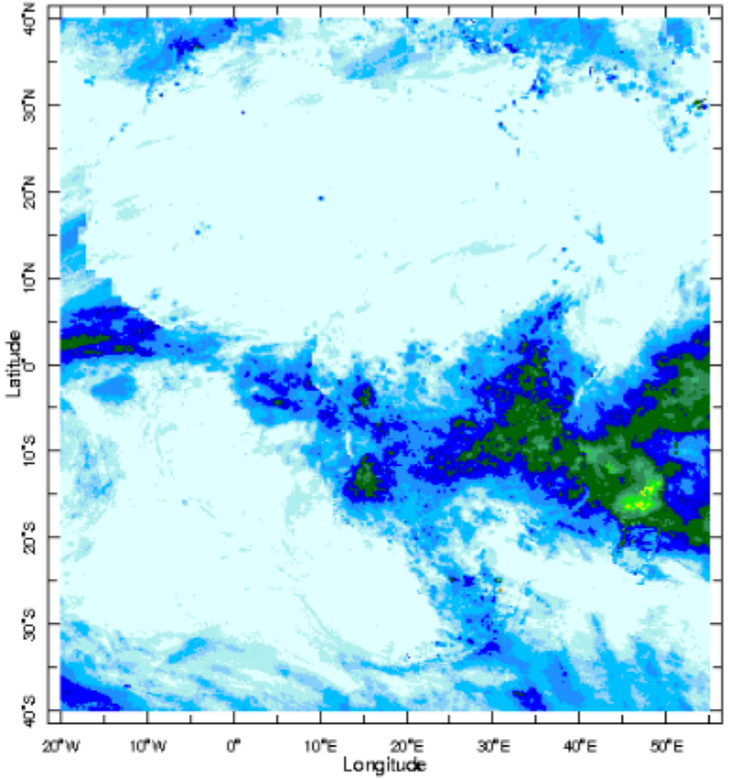
This map shows minimum land surface temperature (LST) used as a proxy for monitoring minimum air temperature.



Precipitation | 20.05W - 55.05E | 40.05S - 40.05N | 2214 30 Nov 1999 - 1346 31 Jan 2020 | WGS 84

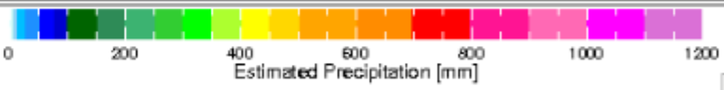
Time: 21-31 Jan 2020 | 11-20 Jan 2020

40.05N



40.05S | 21-31 Jan 2020

20.05W | 55.05E



0 | 1200

Longitude | Latitude | draw ... | colors

Plot size: 432 with 72 border. NimbusSanLSymbol 12

auto color interpolation 1 anti-alias transparent

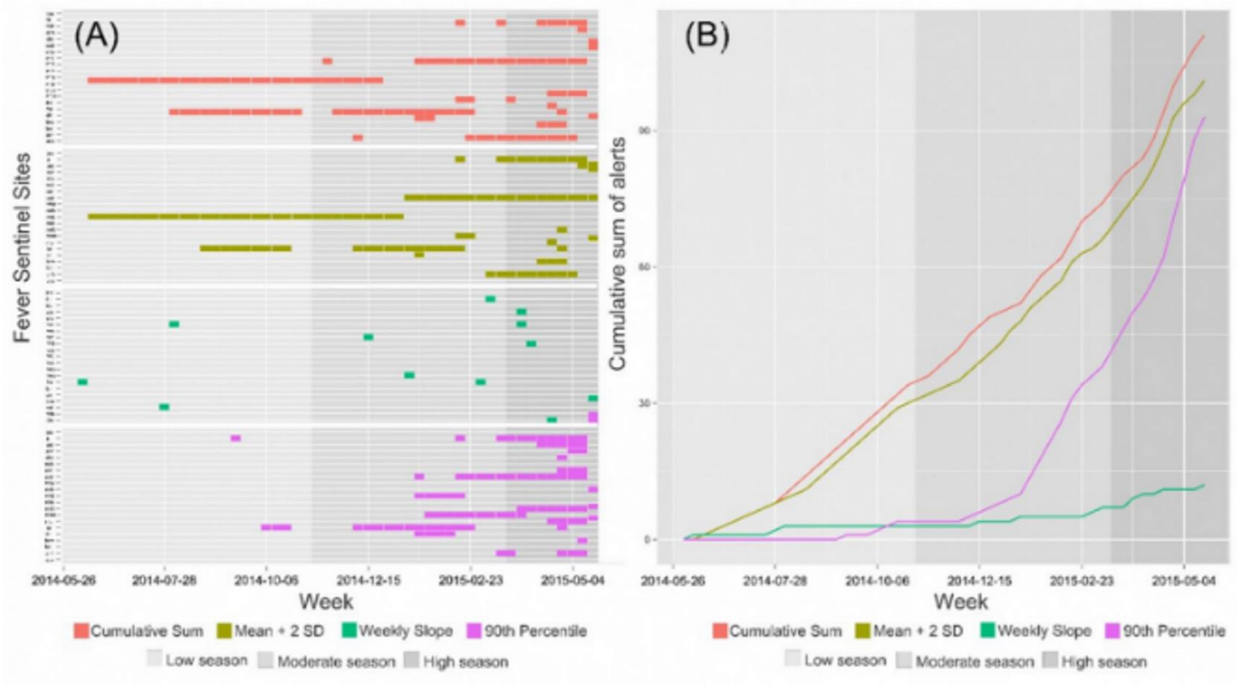
Label starts with

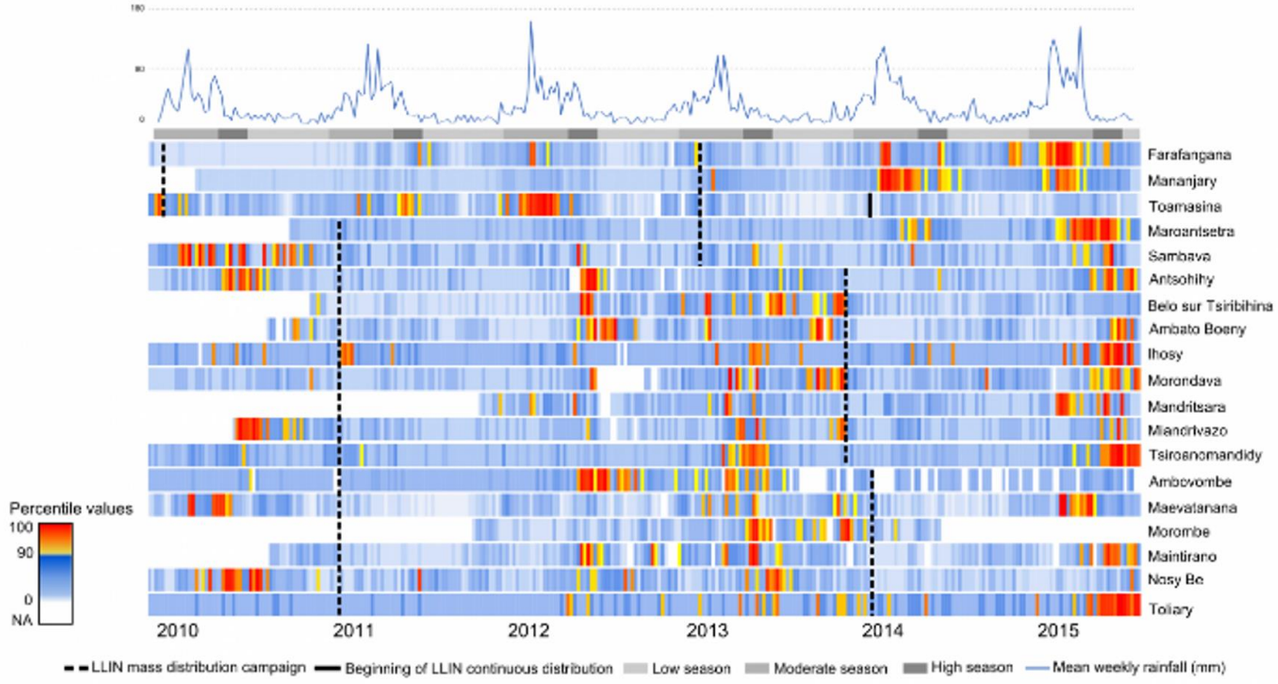
animation frame times (1/100 s): first 25 middle 25 final 200

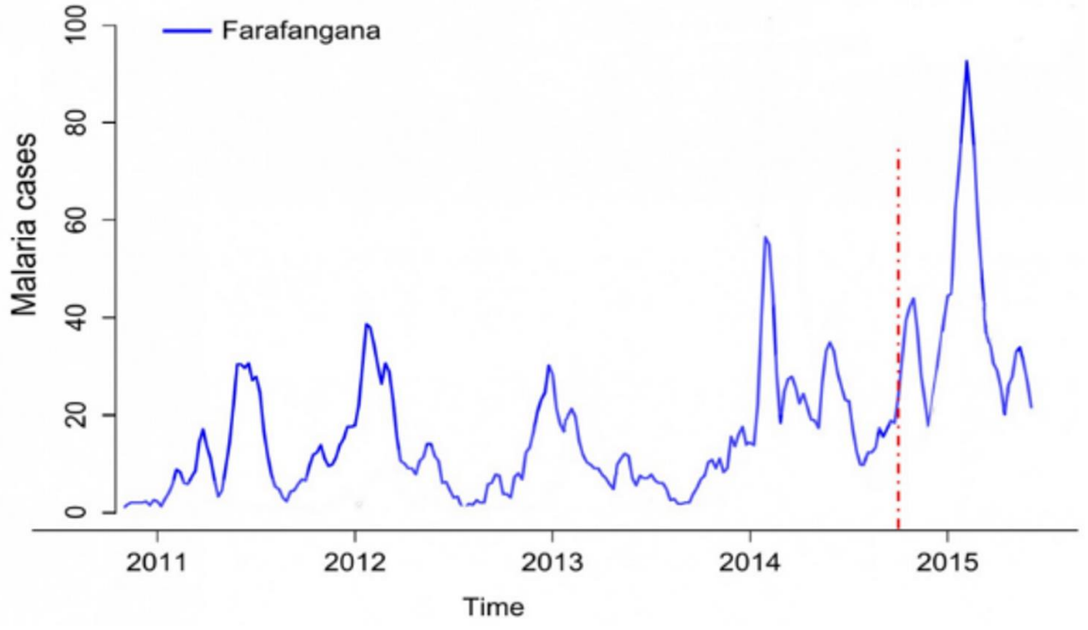
Table 1
Main characteristics and references of the P-datasets. In the data source column, S, R, and G stands for satellite, reanalysis, and gauge information. Spatial coverage refers to the absolute maximum and minimum latitude with precipitation information, and latency refers to the time delay for data availability. The P-datasets including gauge-based information are represented in blue, and italic font is used for P-datasets available in NRT latency of one to three days.

Acronym	Full Name	Data	Temporal Coverage	Temporal Resolution	Spatial Coverage	Spatial Resolution	Latency	Link	References
ARC-2	Africa Rainfall Climatology v.2	S, G	1983–present	Daily	Africa	0.1°	2 days	ftp://ftp.cpc.ncep.noaa.gov/fews/fewsdata/africa/arc2/	Novella and Thiaw (2012)
CHIRP v.2	Climate Hazards Group InfraRed v.2	S, R	1981–present	Daily	50°	0.05°	2 days	ftp://ftp.chg.ucsb.edu/pub/org/chg/products/	Funk et al. (2015)
CHIRPS v.2	CHIRP with Station v.2	S, R, G	1981–present	Daily	50°	0.05°	1 month	ftp://ftp.chg.ucsb.edu/pub/org/chg/products/	Funk et al. (2015)
CMORPH-Raw v.1	Climate Prediction Center MORPHing raw v.1	S	1998–present	3 h	60°	0.25°	2 days	ftp://ftp.cpc.ncep.noaa.gov/precip/CMORPH_V1.0/	Joyce et al. (2004)
CMORPH-CRT v.1	CMORPH bias corrected v.1	S, G	1998–present	3 h	60°	0.25°	6 months	ftp://ftp.cpc.ncep.noaa.gov/precip/CMORPH_V1.0/	Xie et al. (2017)
CMORPH-BLD v.1	CMORPH satellite-gauge merged v.1	S, G	1998–present	Daily	60°	0.25°	10 months	ftp://ftp.cpc.ncep.noaa.gov/precip/CMORPH_V1.0/	Xie et al. (2017)
CPC v.1	Climate Prediction Center unified v.1	G	1979–present	Daily	Global	0,5°	1 days	ftp://ftp.cpc.ncep.noaa.gov/precip/CPC_UNI_PRCP/GAUGE_GLB/	Xie et al. (2007) Chen et al. (2008)
ERA-Interim	European Centre for Medium-range Weather Forecast Re Analysis Interim	R	1979–present	3 h	60°	0.75°	3 months	https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era-interim-land	Dee et al. (2011)
GSMaP-RT v.6	Global Satellite Mapping of Precipitation standard v.6	S	2000–present	Hourly	60°	0.1°	3 days	ftp://hokusai.eorc.jaxa.jp/standard/v6/	Ushio et al. (2009) Yamamoto and Shige (2014)
GSMaP-Adj v.6	GSMaP adjusted v.6	S, G	2000—resent	Hourly	60°	0.1°	3 days	ftp://hokusai.eorc.jaxa.jp/standard/v6/	Ushio et al. (2009) Yamamoto and Shige (2014)
GPCC v.7	Global Precipitation Climatology Center	G	1901–2013	Monthly	Global	1°	Irregular	https://rda.ucar.edu/datasets/ds496.0/	Becker et al. (2013); Schneider et al. (2014)
JRA-55	Japanese 55-year Re Analysis	R	1959–present	3 h	Global	0,56°	1 Month	https://rda.ucar.edu/datasets/ds628.0/	Kobayashi et al. (2015)
JRA-55 Adj	JRA-55 Adjusted	R,G	1959–2013	3 h	Global	0,56°	Stopped	http://search.diasjp.net/en/dataset/S14FD	Izumi et al. (2017)
MERRA-2	Modern-Era Retrospective Analysis for Research and Applications 2	S, R, G	1980–present	Hourly	Global	0,5°	2 Months	https://disc.gsfc.nasa.gov/	Gelaro et al. (2017) Reichle et al. (2017)
MSWEP v.2.2	Multi-Source Weighted Ensemble Precipitation v.2.2	S, R, G	1979–present	3 h	Global	0.1°	Few months	http://www.gloh2o.org/ (Personal communication)	Beck et al. (2018) Beck et al. (2019)
PERSIANN-CDR	Precipitation Estimates from Remotely Sensed Information using Artificial Neural Network and Climate Data Record	S, G	1983–2016	Daily	60°	0.25°	6 months	https://chrsdata.eng.uci.edu/	Ashouri et al. (2015)
PERSIANN-RT	PERSIANN real time	S	2000–present	6 h	60°	0.25°	2 days	https://chrsdata.eng.uci.edu/	Hsu et al. (1997) Sorooshian et al. (2000)
PERSIANN-Adj	PERSIANN Adjusted	S, G	2000–2010	3 h	60°	0.25°	Stopped	http://fire.eng.uci.edu/PERSIANN/	Hsu et al. (1997) Sorooshian et al. (2000)
SM2Rain-CCI v.2	Soil Moisture to Rain applied on ESA Climate Change Initiative v.2	S	1998–2015	Daily	Global	0.25°	Stopped	https://zenodo.org/record/846260#.XQEZtYgzZaQ	Ciabatta et al. (2018)
TAMSAT-v.3	Tropical Applications of Meteorology using SATellite and ground-based observations v.3	S, G	1983–present	Daily	Africa	0.0375°	3 days	https://www.tamsat.org.uk/about	Maidment et al. (2017)
TMPA-RT v.7	TRMM Multi-satellite Precipitation Analysis Real Time v.7	S	1998–present	3 h	60°	0.25°	1 day	https://mirador.gsfc.nasa.gov/	Huffman et al. (2018) Huffman et al. (2010)
TMPA-Adj v.7	TMPA Adjusted v.7	S, G	2000–present	3 h	50°	0.25°	3 months	https://earthdata.nasa.gov/	Huffman et al. (2018) Huffman et al. (2010)
WFDEI	WATCH Forcing Data methodology applied to ERA-Interim	R, G	1979–2016	Daily	Land	0.5°	Stopped	ftp://ftp.iiasa.ac.at/	Weedon et al. (2014)

Satgé, F., Defrance, D., Sultan, B., Bonnet, M. P., Seyler, F., Rouché, N., Pierron, F., & Paturel, J. E. (2020). Evaluation of 23 gridded precipitation datasets across West Africa. Journal of Hydrology, 581(July 2019), 124412.
https://doi.org/10.1016/j.jhydrol.2019.124412







- New malaria epidemic threshold (less constraints)

- Ability to detect the 2014-10-06 outbreak in the southeastern part of the country.

- Real-time evaluation of the impact of malaria control interventions

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de Madagascar


Espace
Dev


IRD
Institut de recherche
pour le développement


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S'ouvrir aux mondes


Réseau International
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PROJECT


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USA


CDC
CENTERS FOR DISEASE
CONTROL AND PREVENTION


FRANCE
VOLONTAIRES
Echanges et solidarité internationale

Malaria Early Warning System Madagascar (2012 - 2016)

using a sentinel surveillance system

Malaria surveillance web tools (2019 -...)

Schoclo malaria reasearch unit (SMRU)

Malaria Early Warning System Madagascar (2012 - 2016)

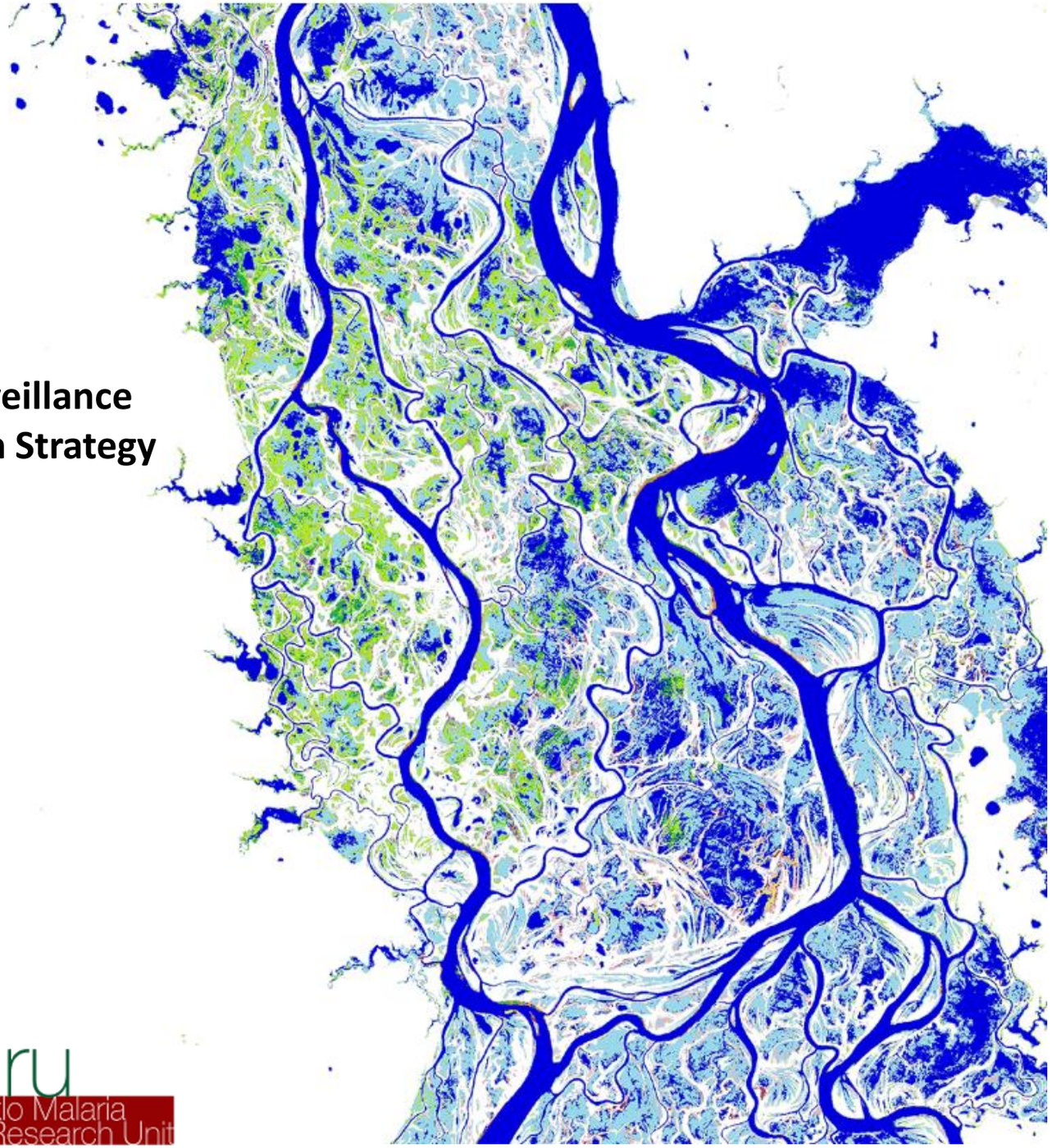
using a sentinel surveillance system

Malaria surveillance web tools (2019 -...)

Schoclo malaria reasearch unit (SMRU)

EASIMES

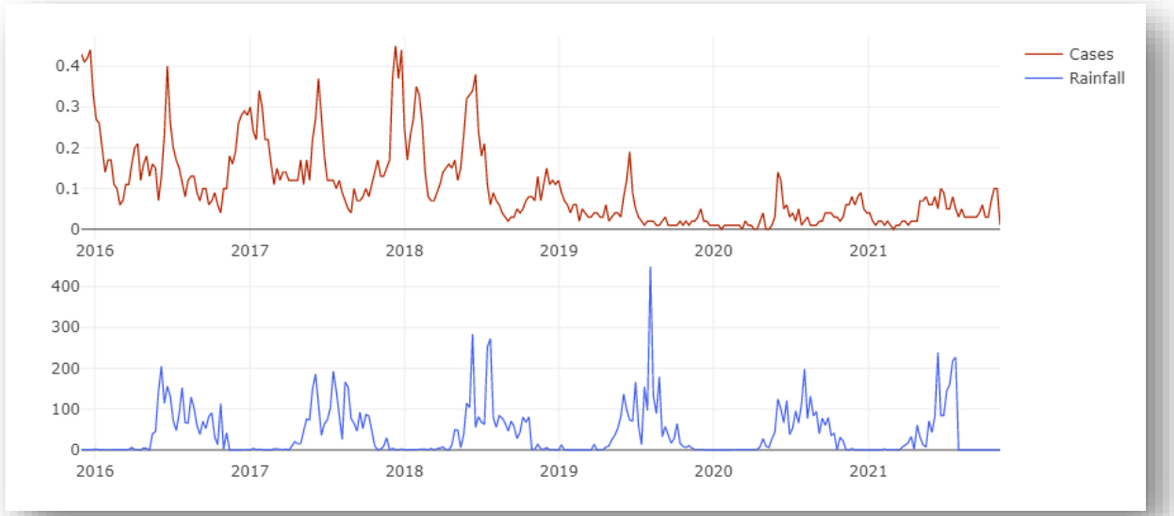
Environment Analysis and Surveillance to Improve Malaria Elimination Strategy



Smru
Shoklo Malaria Research Unit

Environmental conditions, including environmental/climate variability and land use practices, along with socioeconomic influences, political instability, and regional migration might compromise malaria elimination goals in this region.

EASIMES Project (2019-2021) aims at improving the understanding of environmental conditions which influence malaria transmission in the forested environments of Eastern Myanmar in order to improve microstratification and active surveillance tools used by the control and/or elimination programs.



4 main activities:

- Accurate mapping of land-use/land-cover and monitoring of fluctuations in environmental conditions
- Defining the malaria epidemiological landscape: spatio-temporal analysis
- Defining vector-suitable high-risk environments
- Development of a Malaria environmental surveillance system

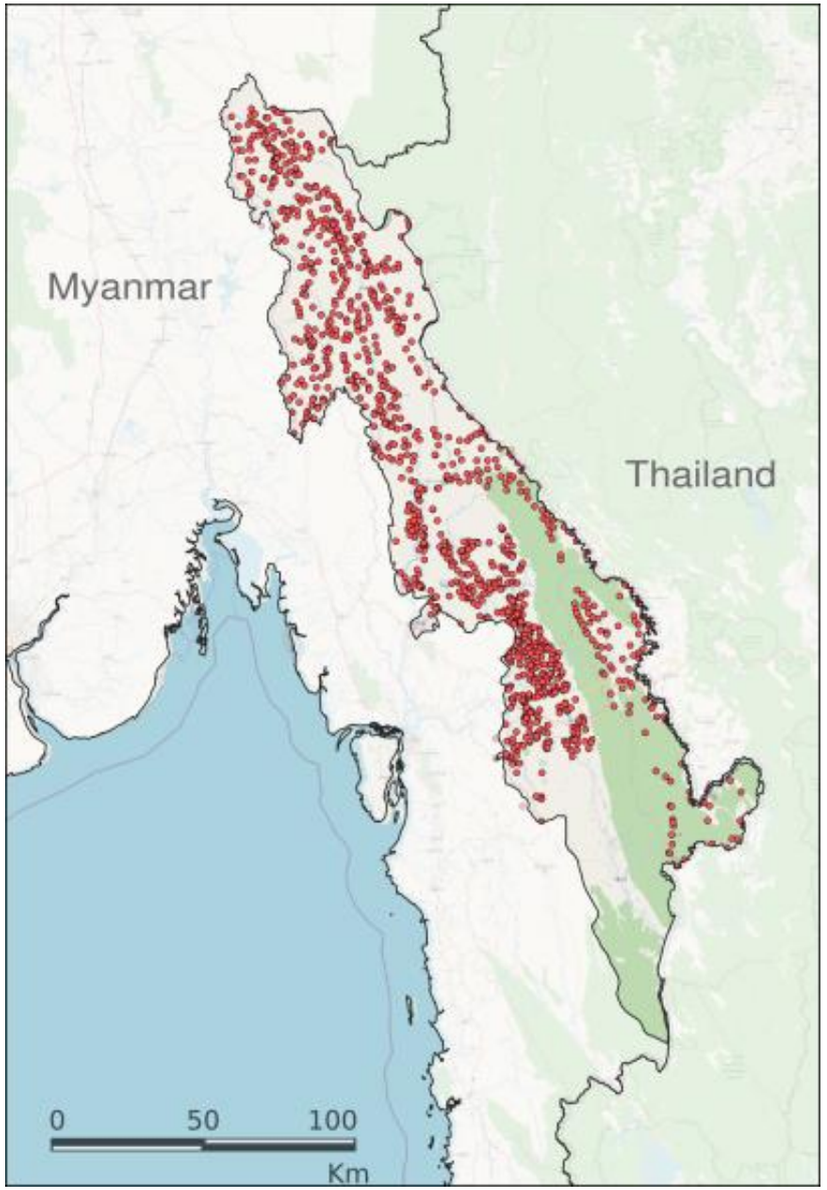
Malaria Environmental Surveillance System

Malaria Elimination Task Force

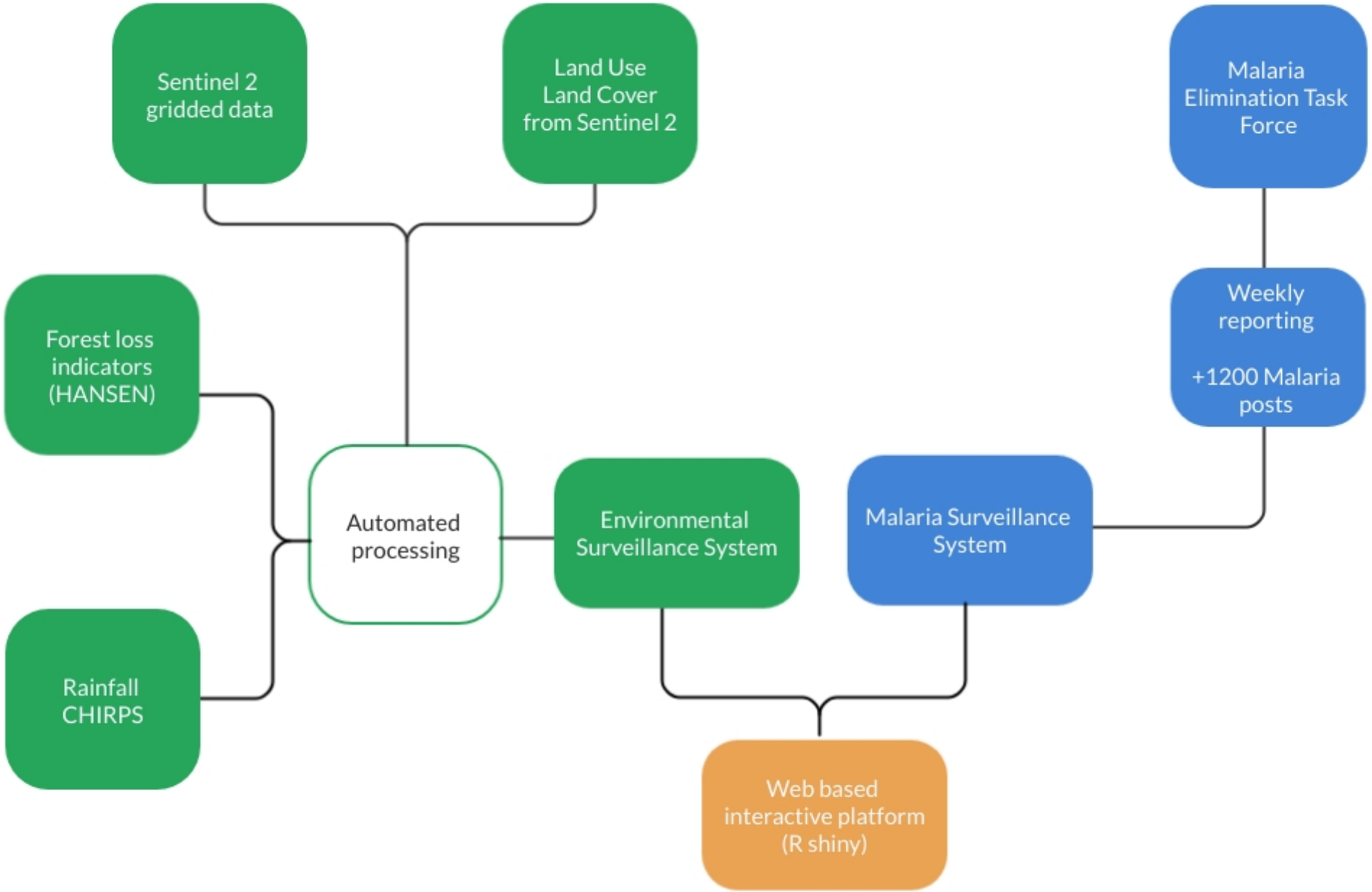
- 1200+ Malaria Posts reporting **weekly** village-level *P. falciparum* and *P. vivax* incidence deployed since June **2014**

The development of **web-based** data management **platforms** has been proposed as a critical strategy for strengthening surveillance by **automating** major data processing steps, enabling data access, and integrating **surveillance** data with other relevant **sources of information** (Interpretation / contextualization) **in a prospective setting.**

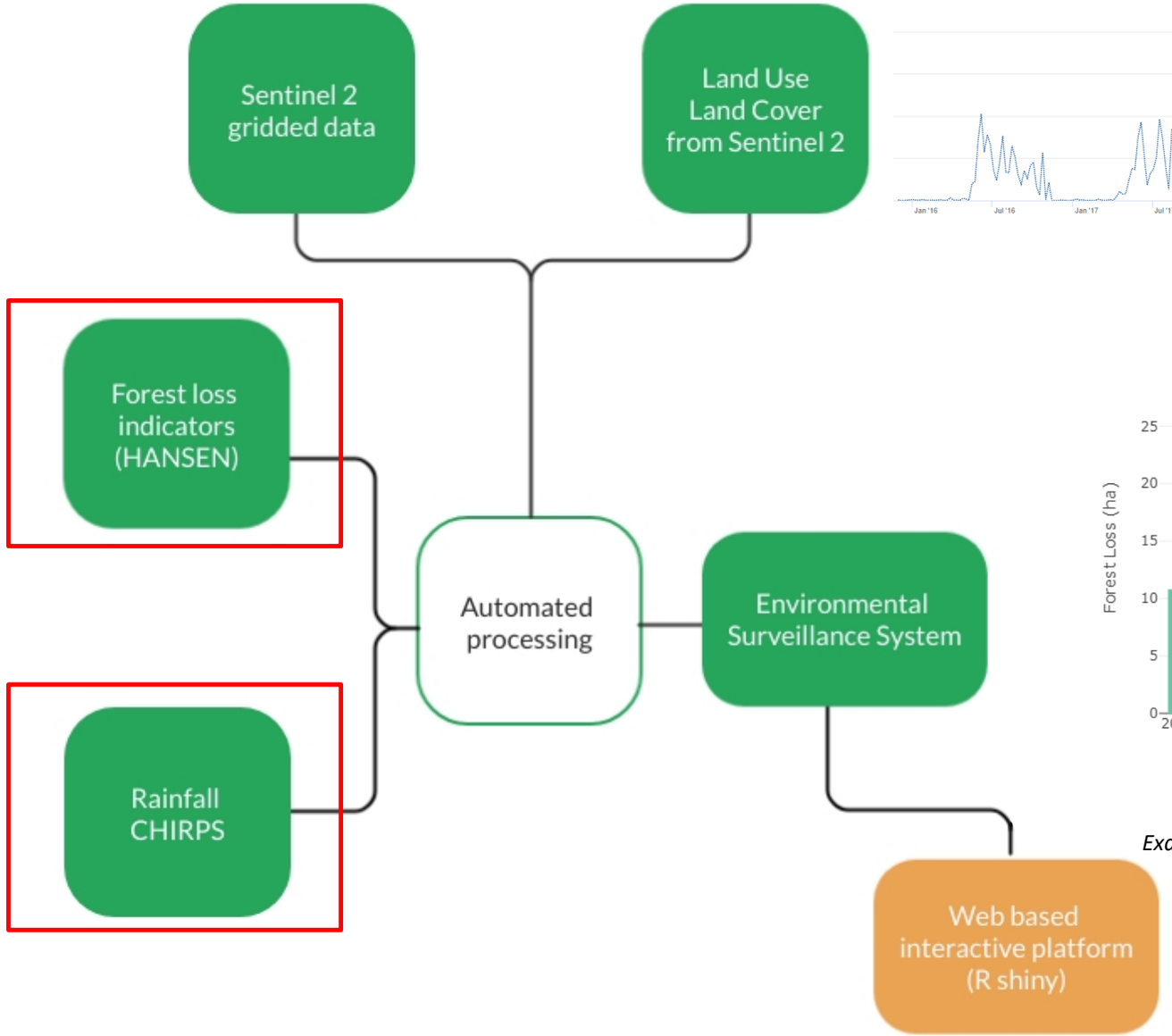
Data visualization and exploratory analysis techniques have been widely used in scientific research to support the understanding of data for epidemiological inference and contextualization and eventually provide evidence to generate new hypotheses to test.

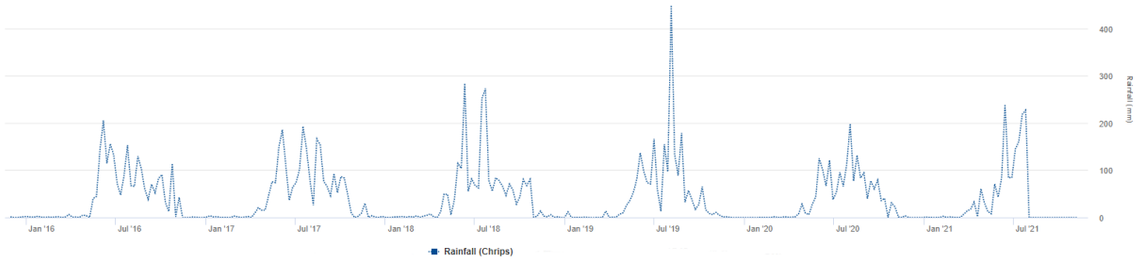


Malaria Environmental Surveillance System

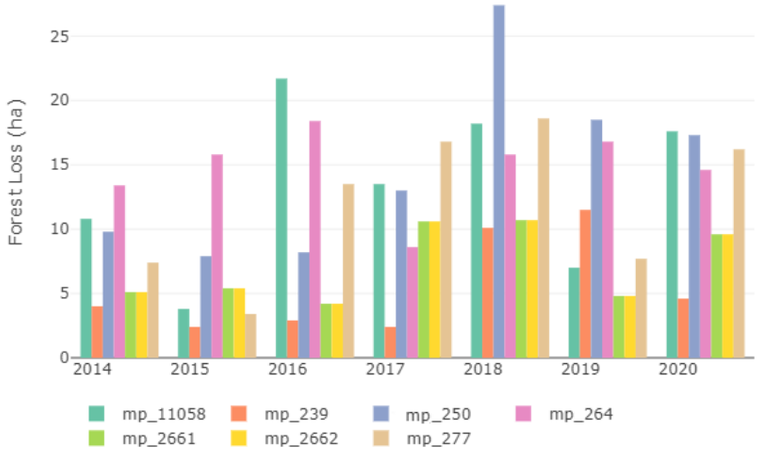


Malaria Environmental Surveillance System





Weekly time series of Rainfall
CHIRPS v.2



Example of yearly time series of Forest loss by ha over a few malaria posts
HANSEN

SMRU. Shoklo Malaria Research Unit

IRD Institut de Recherche pour le Développement FRANCE

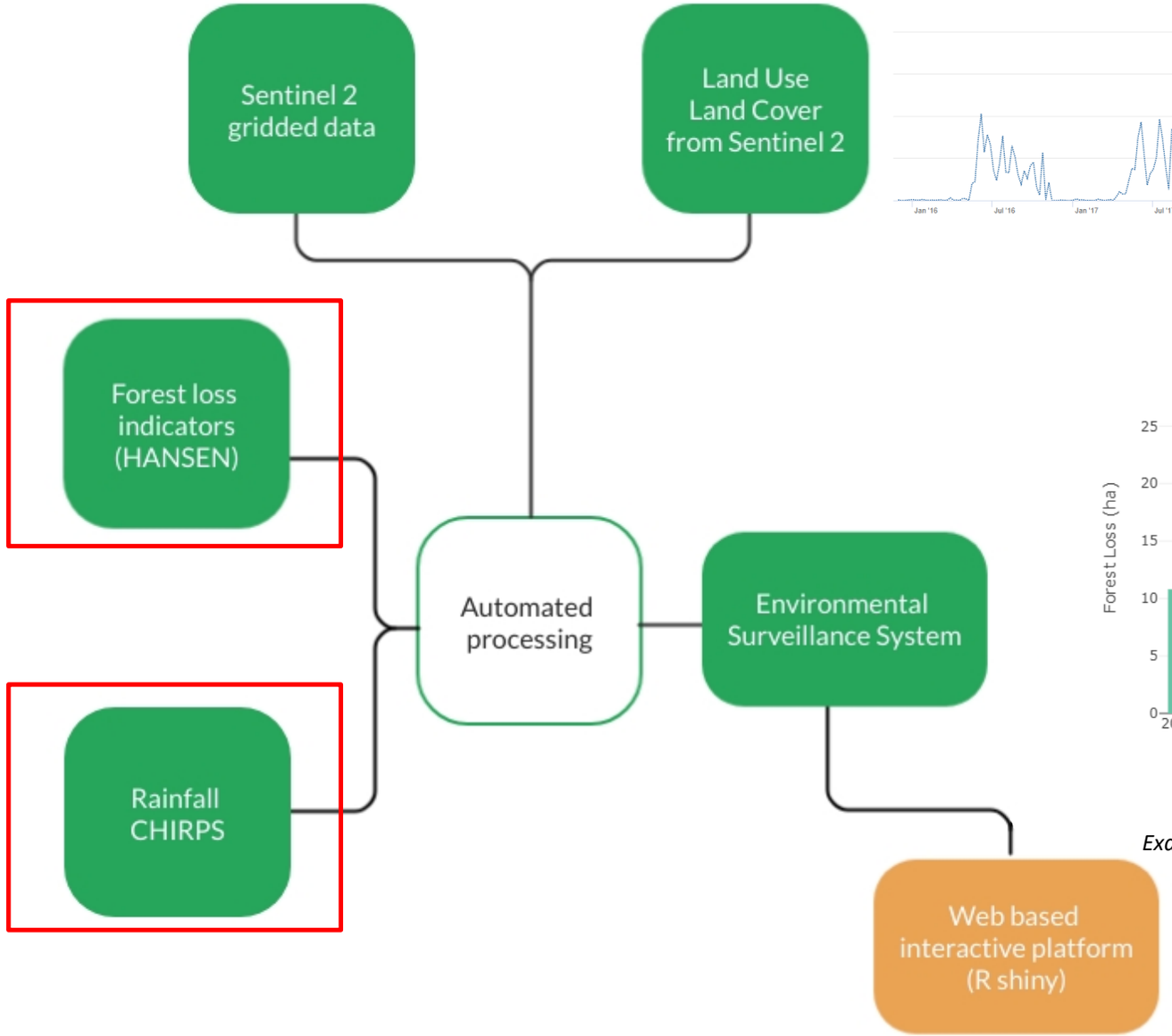
Malaria Environmental Surveillance System

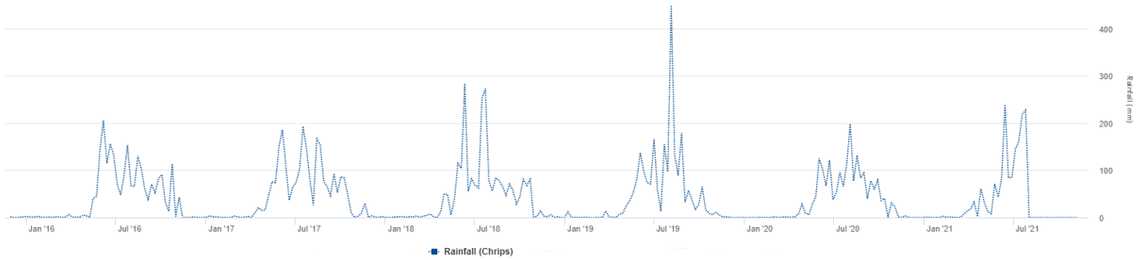
Acronym	Full Name	Data	Temporal Coverage	Temporal Resolution	Spatial Coverage	Spatial Resolution	Latency	Link	References
ARC-2	Africa Rainfall Climatology v.2	S, G	1983–present	Daily	Africa	0.1°	2 days	ftp://ftp.cpc.ncep.noaa.gov/fews/fewsdata/africa/arc2/	Novella and Thiaw (2012)
CHIRP v.2	Climate Hazards Group InfraRed v.2	S, R	1981–present	Daily	50°	0.05°	2 days	ftp://ftp.chg.ucsb.edu/pub/org/chg/products/	Funk et al. (2015)
CHIRPS v.2	CHIRP with Station v.2	S, R, G	1981–present	Daily	50°	0.05°	1 month	ftp://ftp.chg.ucsb.edu/pub/org/chg/products/	Funk et al. (2015)
CMORPH-Raw v.1	Climate Prediction Center MORPHing raw v.1	S	1998–present	3 h	60°	0.25°	2 days	ftp://ftp.cpc.ncep.noaa.gov/precip/CMORPH_V1.0/	Joyce et al. (2004)
CMORPH-CRT v.1	CMORPH bias corrected v.1	S, G	1998–present	3 h	60°	0.25°	6 months	ftp://ftp.cpc.ncep.noaa.gov/precip/CMORPH_V1.0/	Xie et al. (2017)
CMORPH-BLD v.1	CMORPH satellite-gauge merged v.1	S, G	1998–present	Daily	60°	0.25°	10 months	ftp://ftp.cpc.ncep.noaa.gov/precip/CMORPH_V1.0/	Xie et al. (2017)
CPC v.1	Climate Prediction Center unified v.1	G	1979–present	Daily	Global	0,5°	1 days	ftp://ftp.cpc.ncep.noaa.gov/precip/CPC_UNI_PRCP/GAUGE_GLB/	Xie et al. (2007) Chen et al. (2008)
ERA-Interim	European Centre for Medium-range Weather Forecast Re Analysis Interim	R	1979–present	3 h	60°	0.75°	3 months	https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era-interim-land	Dee et al. (2011)
GSMaP-RT v.6	Global Satellite Mapping of Precipitation standard v.6	S	2000–present	Hourly	60°	0.1°	3 days	ftp://hokusai.eorc.jaxa.jp/standard/v6/	Ushio et al. (2009) Yamamoto and Shige (2014)
GSMaP-Adj v.6	GSMaP adjusted v.6	S, G	2000–resent	Hourly	60°	0.1°	3 days	ftp://hokusai.eorc.jaxa.jp/standard/v6/	Ushio et al. (2009) Yamamoto and Shige (2014)
GPCC v.7	Global Precipitation Climatology Center	G	1901–2013	Monthly	Global	1°	Irregular	https://rda.ucar.edu/datasets/ds496.0/	Becker et al. (2013); Schneider et al. (2014)
JRA-55	Japanese 55-year Re Analysis	R	1959–present	3 h	Global	0,56°	1 Month	https://rda.ucar.edu/datasets/ds628.0/	Kobayashi et al. (2015)
JRA-55 Adj	JRA-55 Adjusted	R,G	1959–2013	3 h	Global	0,56°	Stopped	http://search.diasjp.net/en/dataset/S14FD	Izumi et al. (2017)
MERRA-2	Modern-Era Retrospective Analysis for Research and Applications 2	S, R, G	1980–present	Hourly	Global	0,5°	2 Months	https://disc.gsfc.nasa.gov/	Gelaro et al. (2017) Reichle et al. (2017)
MSWEP v.2.2	Multi-Source Weighted Ensemble Precipitation v.2.2	S, R, G	1979–present	3 h	Global	0.1°	Few months	http://www.gloh2o.org/ (Personal communication)	Beck et al. (2018) Beck et al. (2019)
PERSIANN-CDR	Precipitation Estimates from Remotely Sensed Information using Artificial Neural Network and Climate Data Record	S, G	1983–2016	Daily	60°	0.25°	6 months	https://chrsdata.eng.uci.edu/	Ashouri et al. (2015)
PERSIANN-RT	PERSIANN real time	S	2000–present	6 h	60°	0.25°	2 days	https://chrsdata.eng.uci.edu/	Hsu et al. (1997) Sorooshian et al. (2000)
PERSIANN-Adj	PERSIANN Adjusted	S, G	2000–2010	3 h	60°	0.25°	Stopped	http://fire.eng.uci.edu/PERSIANN/	Hsu et al. (1997) Sorooshian et al. (2000)
SM2Rain-CCI v.2	Soil Moisture to Rain applied on ESA Climate Change Initiative v.2	S	1998–2015	Daily	Global	0.25°	Stopped	https://zenodo.org/record/846260#.XQEZtYgzZaQ	Ciabatta et al. (2018)
TAMSAT-v.3	Tropical Applications of Meteorology using SATellite and ground-based observations v.3	S, G	1983–present	Daily	Africa	0.0375°	3 days	https://www.tamsat.org.uk/about	Maidment et al. (2017)
TMPA-RT v.7	TRMM Multi-satellite Precipitation Analysis Real Time v.7	S	1998–present	3 h	60°	0.25°	1 day	https://mirador.gsfc.nasa.gov/	Huffman et al. (2018) Huffman et al. (2010)
TMPA-Adj v.7	TMPA Adjusted v.7	S, G	2000–present	3 h	50°	0.25°	3 months	https://earthdata.nasa.gov/	Huffman et al. (2018) Huffman et al. (2010)
WFDEI	WATCH Forcing Data methodology applied to ERA-Interim	R, G	1979–2016	Daily	Land	0.5°	Stopped	ftp://ftp.iiasa.ac.at/	Weedon et al. (2014)

Satgé, F., Defrance, D., Sultan, B., Bonnet, M. P., Seyler, F., Rouché, N., Pierron, F., & Paturel, J. E. (2020). Evaluation of 23 gridded precipitation datasets across West Africa. Journal of Hydrology, 581(July 2019), 124412.

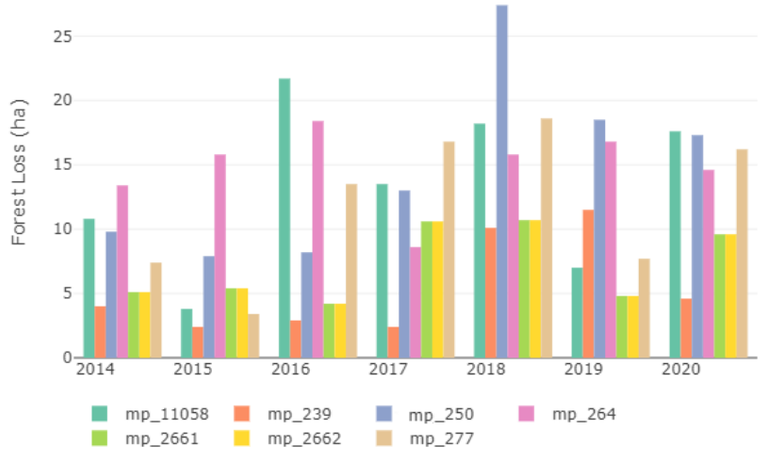
https://doi.org/10.1016/j.jhydrol.2019.124412

Malaria Environmental Surveillance System



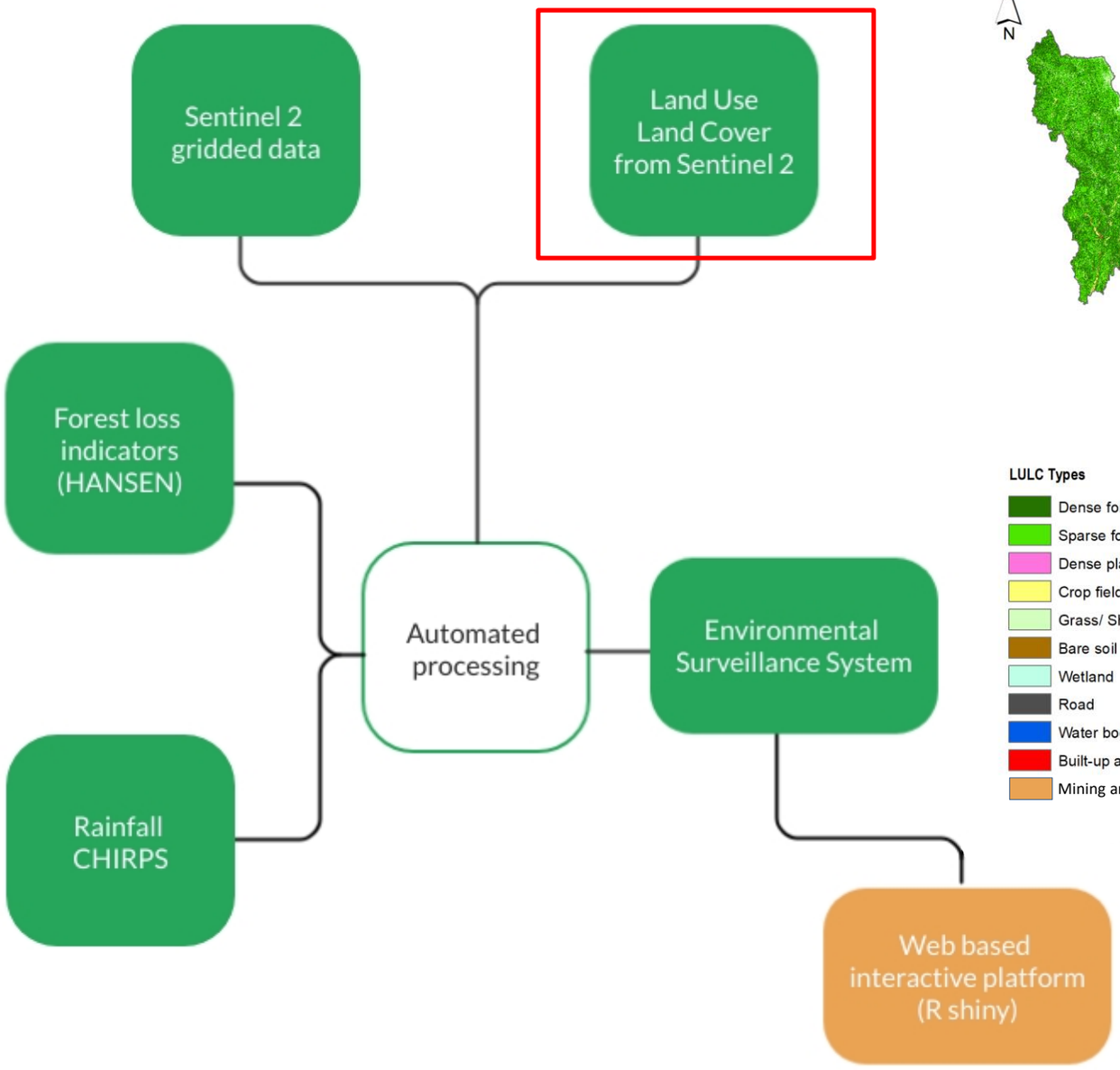


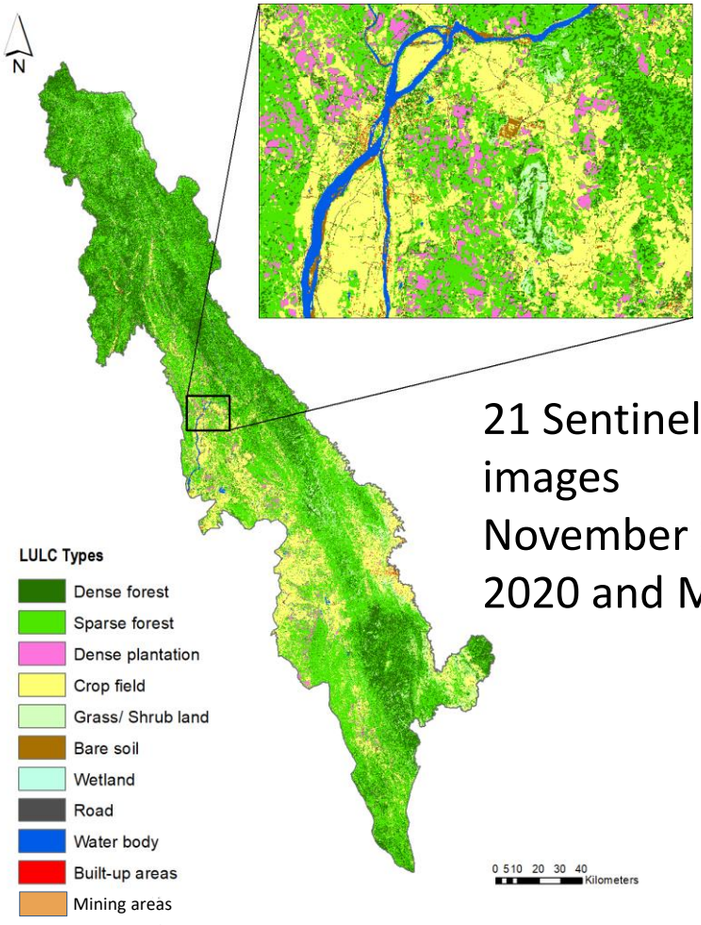
Weekly time series of Rainfall
CHIRPS v.2



Example of yearly time series of Forest loss by ha over a few malaria posts
HANSEN (~30 m spatial resolution)

Malaria Environmental Surveillance System

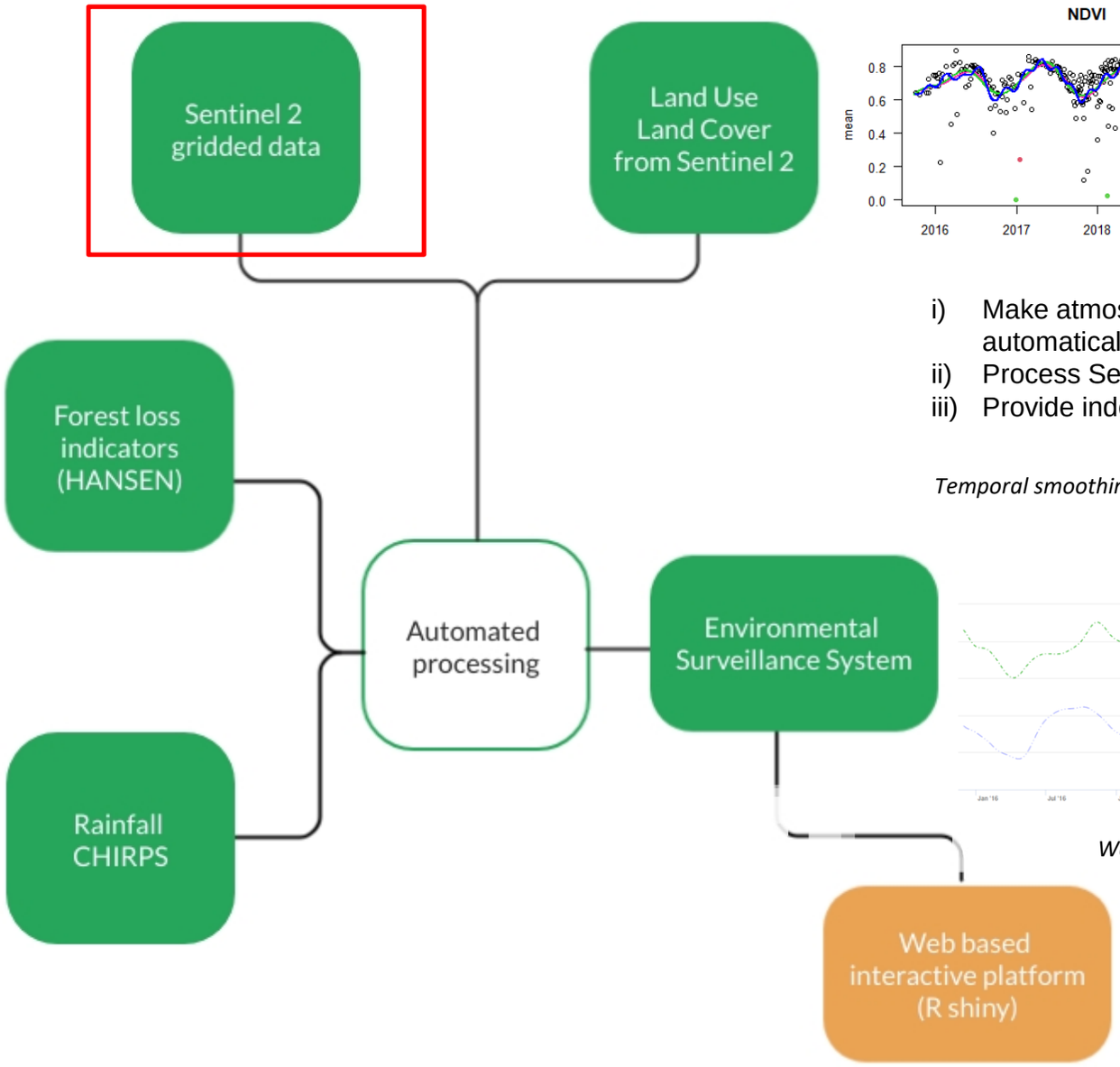


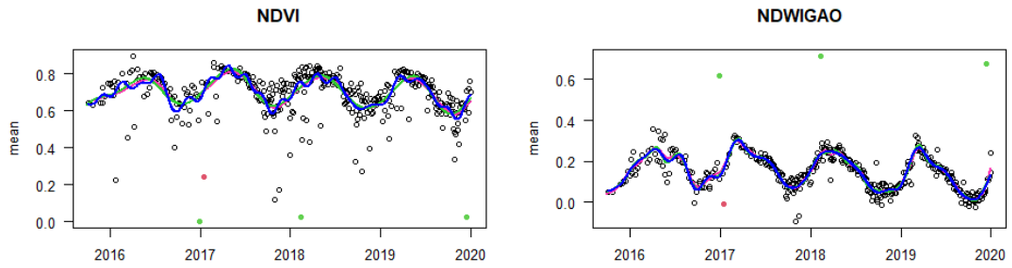


21 Sentinel-2 satellite images
November 2019, January 2020 and March 2020

Object-based image analysis (OBIA) with eCognition

Malaria Environmental Surveillance System

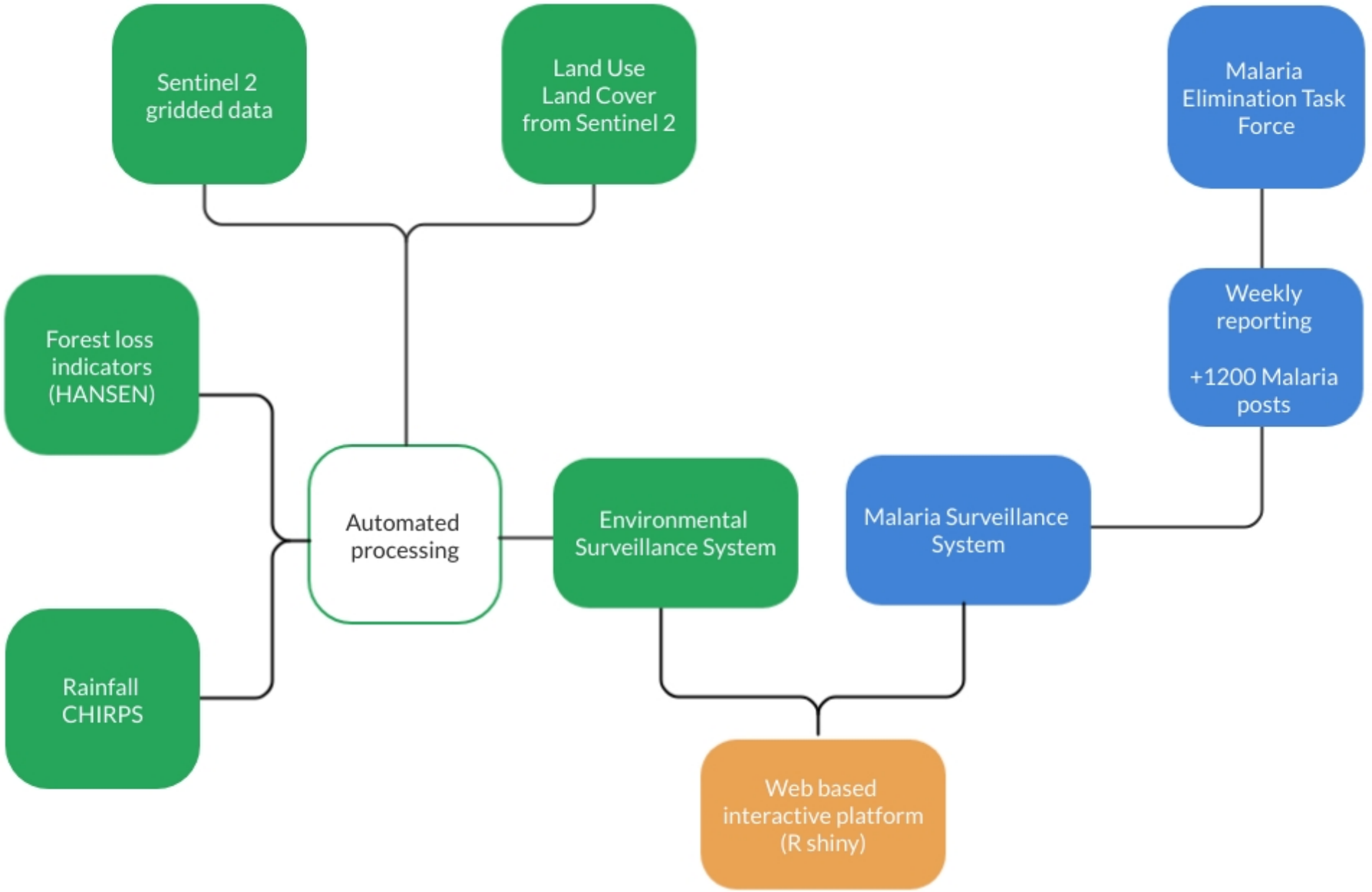




i) Make atmospheric conditions correction (SEN2COR algorithm) automatically and routinely
ii) Process Sentinel2 from L1C to L2A level (Sen2Chain) and
iii) Provide index production and time series computation

Temporal smoothing of NDVI and NDWI Gao indices, with three methods
Cubic-spline
B-spline
Fourier transform

Weekly time series of vegetation and humidity indices
Sentinel 2, Copernicus


Sentinel 2 gridded data
Land Use Land Cover from Sentinel 2
Malaria Elimination Task Force
Forest loss indicators (HANSEN)
Weekly reporting
+1200 Malaria posts
Automated processing
Environmental Surveillance System
Malaria Surveillance System
Rainfall CHIRPS
Web based interactive platform (R shiny)

Summary | Environmental Time Series

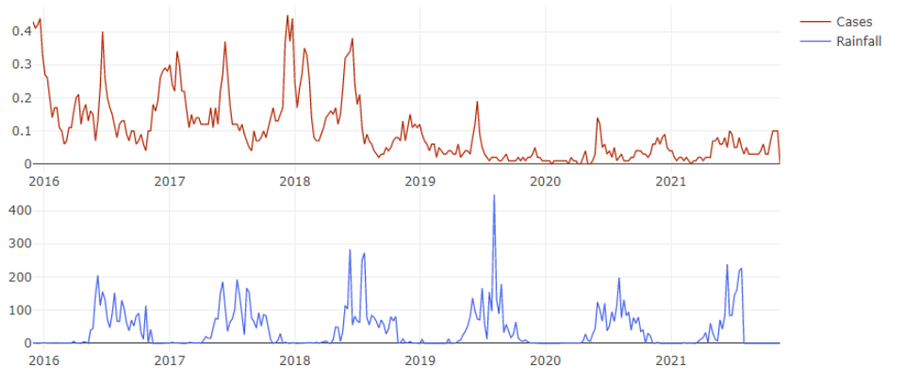
Press for instructions

Malaria species:

- (•) Falciparum
- ( ) Vivax

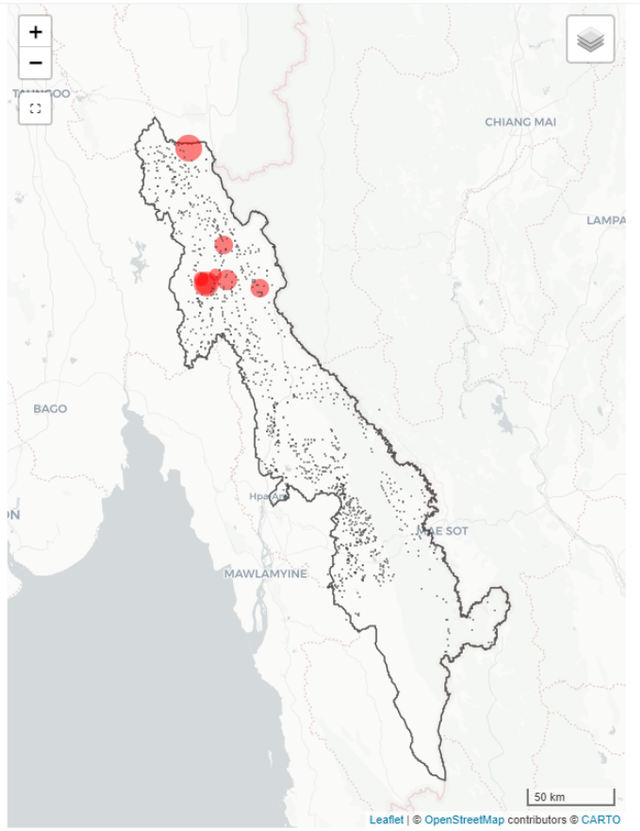
- (•) Malaria incidence
- ( ) Malaria cases

- [ ] Stacked or Grouped

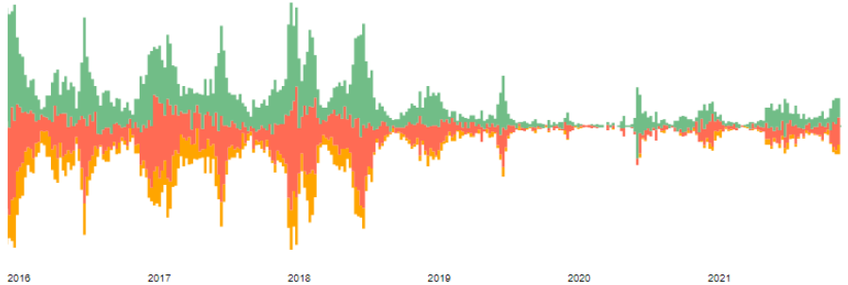


Search:

Malaria post	Date	Cases	Incidence (/1000)	Age 0 to 5	Age 5 to 15	Age 15 to 99
mp_2661	2020-10-19	2	11.76	0%	50%	50%
mp_37	2020-10-19	2	22.99	0%	0%	100%
mp_176	2020-10-19	1	9.09	0%	0%	100%
mp_239	2020-10-19	1	4.03	0%	0%	100%
mp_254	2020-10-19	1	6.02	0%	0%	100%
mp_2662	2020-10-19	1	18.18	0%	0%	100%
mp_278	2020-10-19	1	10.31	0%	100%	0%
mp_2982	2020-10-19	1	10.87	0%	0%	100%

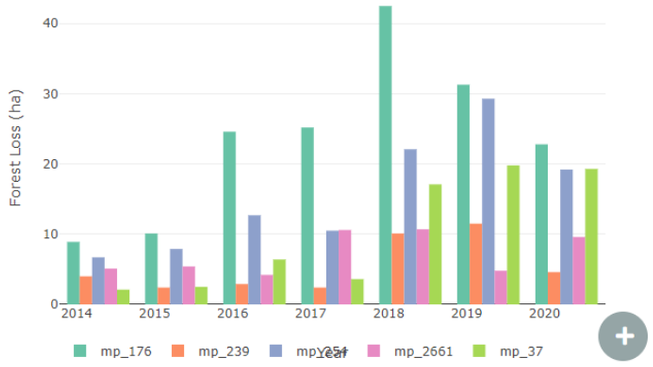


Age group



Age group: --- Select ---

Forest Loss (Hansen)



Summary | Environmental Time Series

Environmental variables

- [x] Rainfall
- [ ] NDVI
- [ ] MNDWI
- [ ] NDWIGAO

Number of lagged weeks for rainfall

1 [7] 52

1 7 13 19 25 31 37 43 49

Number of lagged weeks for NDVI

[1] 52

1 7 13 19 25 31 37 43 49

Number of lagged weeks for MNDWI

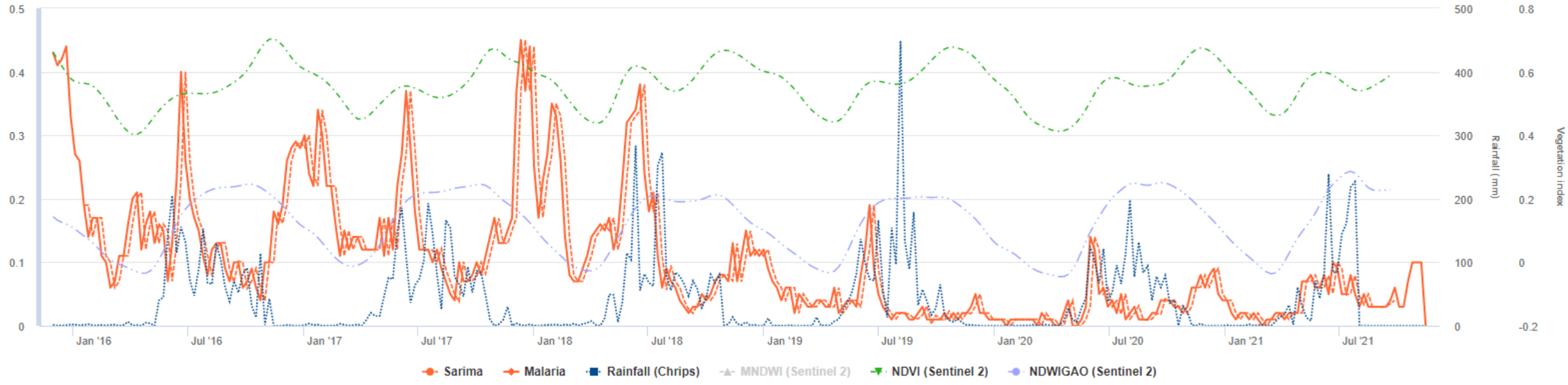
[2] 52

1 7 13 19 25 31 37 43 49

Number of lagged weeks for NDWIGAO

[2] 52

1 7 13 19 25 31 37 43 49



Rainfall lag association 7 week(s)

MNDWI lag association 2 week(s)

NDVI lag association 1 week(s)

NDWIGAO lag association 2 week(s)

SARIMA AIC -1038.7

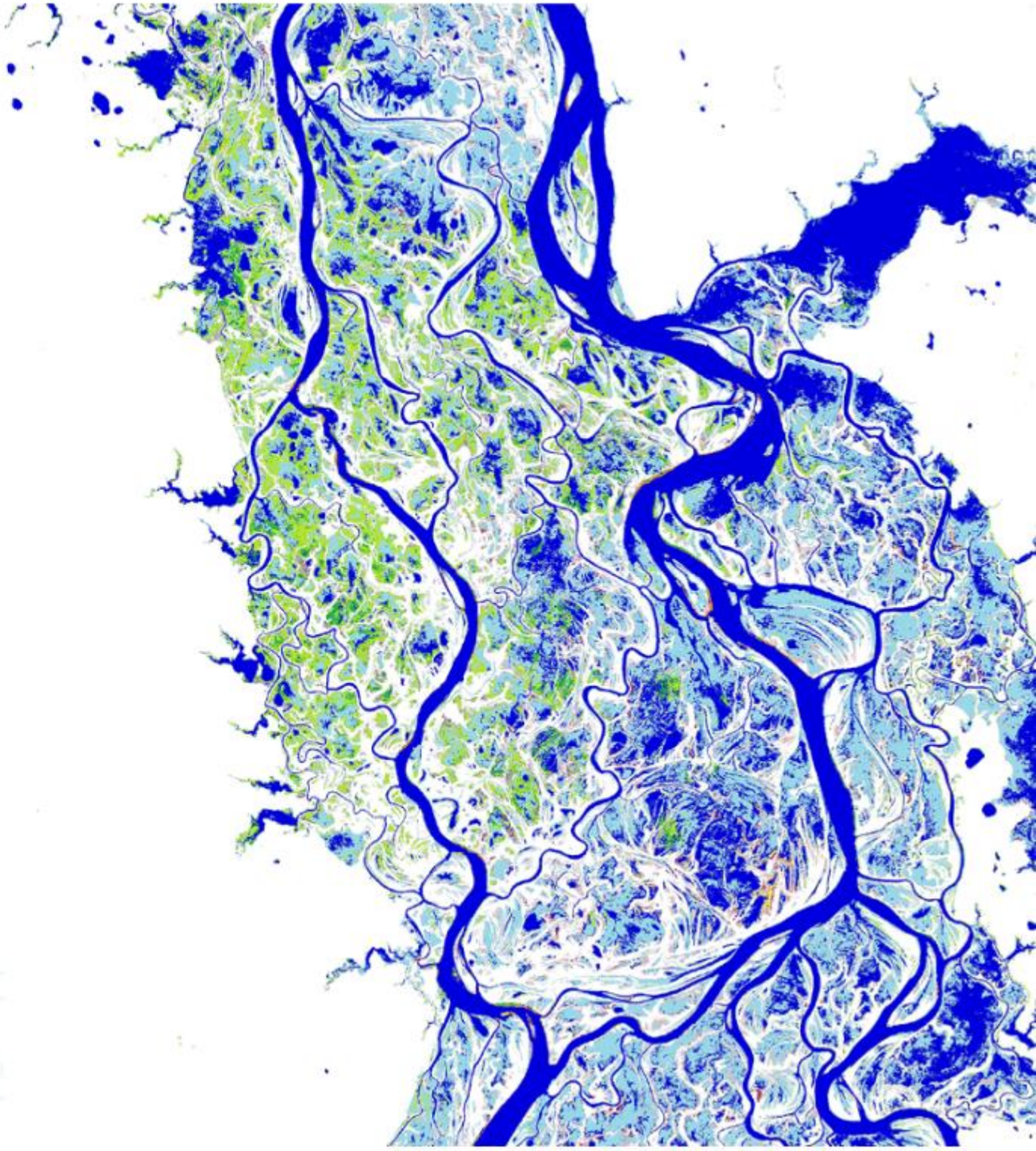
Search:

	coef_sarima[,]
Estimate	-0.000021
Std. Error	0.000074
z value	-0.280548
Pr(>|z|)	0.779057

TheGlobalFund

UNOPS

- Associating remote sensing environmental monitoring with malaria surveillance requires close and interdisciplinary collaboration.
- Critical points include the need to develop software tools and an enabling environment to provide timely harmonized epidemiological and environmental data.
- The importance of continual stakeholder input throughout the sign, implementation, and operation of the system, and the need to be adaptable to changes in the input data and expected output.
- The use of remotely sensed data in malaria decision support or broadly in an epidemiological surveillance system is still limited with a limited number of published studies describing their implementation, especially for operational purposes.



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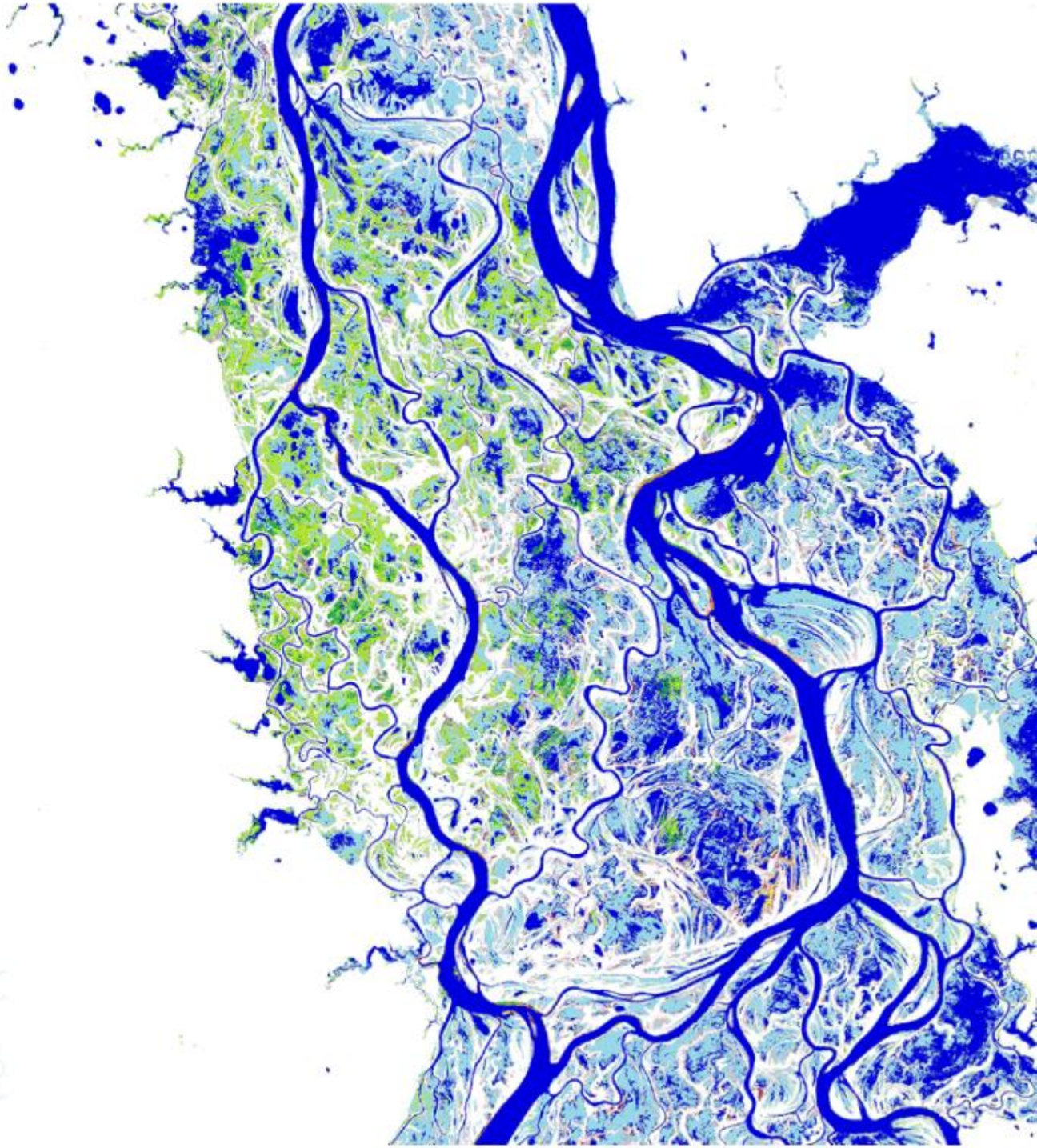
Institut Pasteur du Cambodge

THANK YOU



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