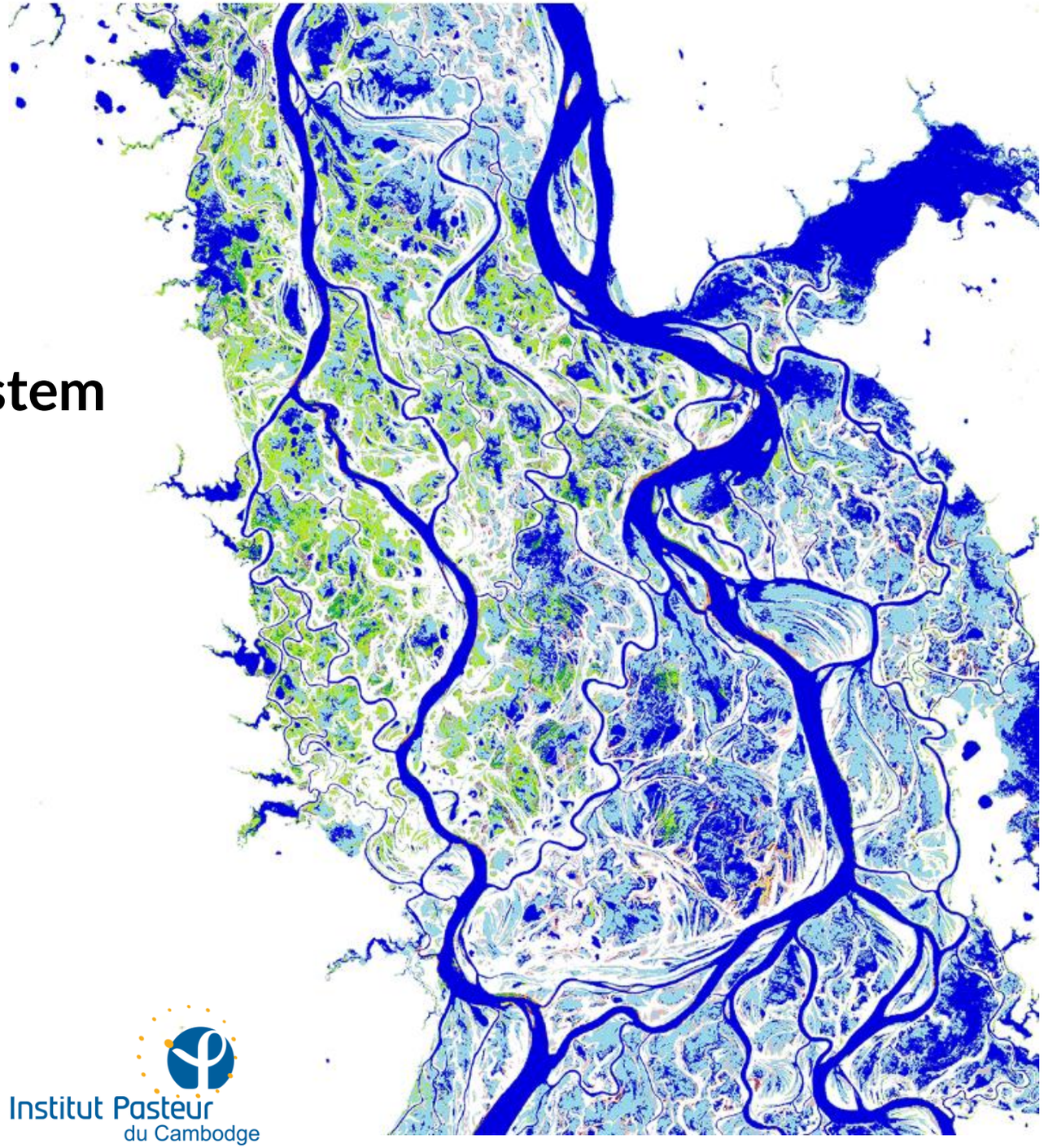
Malaria environmental surveillance system

Easimes Platform

Florian Girond



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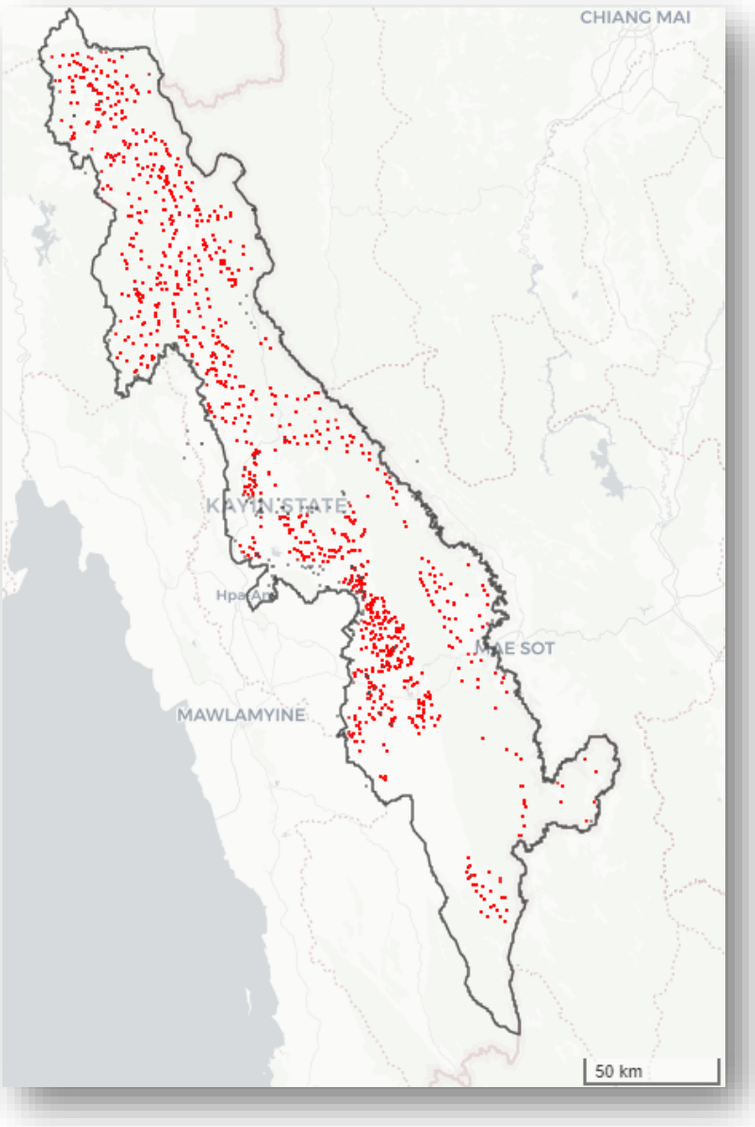
Environment analysis and surveillance to improve malaria elimination strategies

EASIMES Project aims at improving the understanding of **environmental conditions which influence malaria transmission** in the forested environments of Eastern Myanmar

- support microstratification and active surveillance tools used by the control and/or elimination programs.



Malaria Elimination Task Force

- Community-based access to early diagnosis and treatment of over 1250 malaria posts
- Provide early access to diagnosis (RDTs), and treatment (ACTs)

<u>4 main activities:</u>

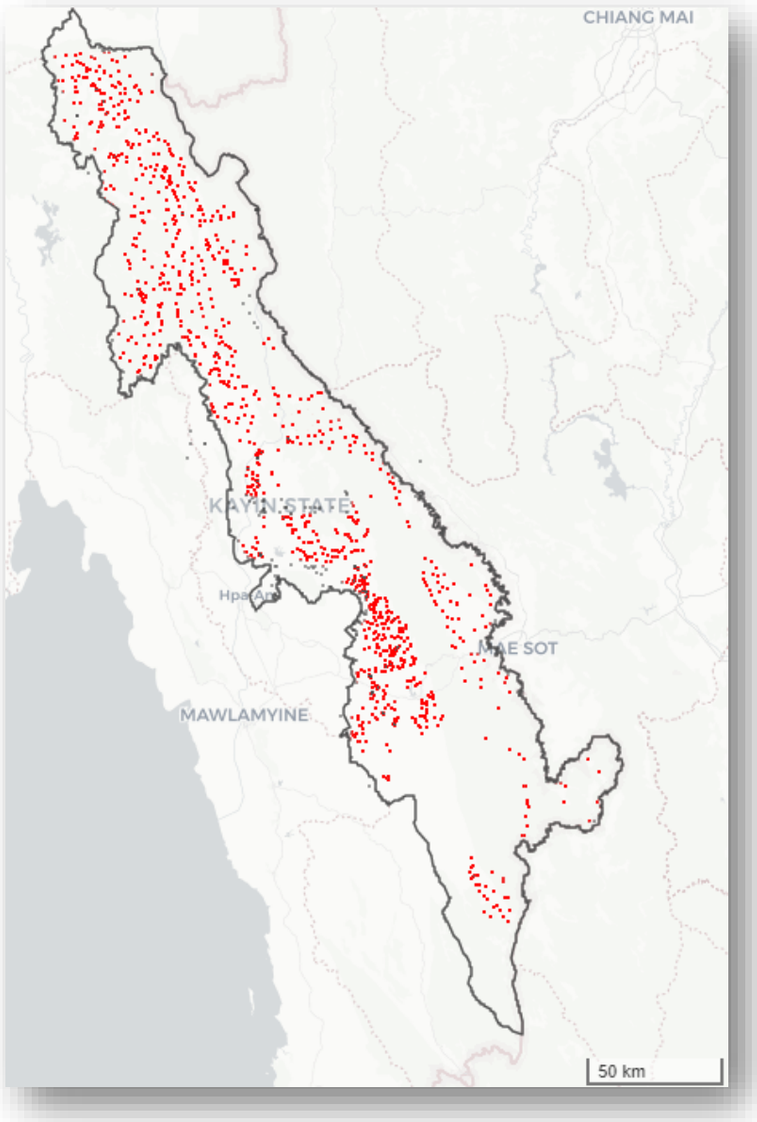
- Accurate mapping of land-use/land cover and monitoring of fluctuations in environmental conditions
- Defining the malaria epidemiological landscape: Spatio-temporal analysis
- Defining vector-suitable high-risk environments
- Development of a Malaria environmental surveillance system

Malaria **Environmental Surveillance** System

Easimes platform for strengthening surveillance by:

- **automating** major data processing steps
- enabling data access **– Interactive Web-based system**
- **integrating surveillance data** with other relevant sources of information 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.



Critical points include :

- Providing timely harmonized epidemiological and environmental data.
- The need to be adaptable to consider continual stakeholder input throughout the sign, implementation, and operation of the system: versatility/flexibility

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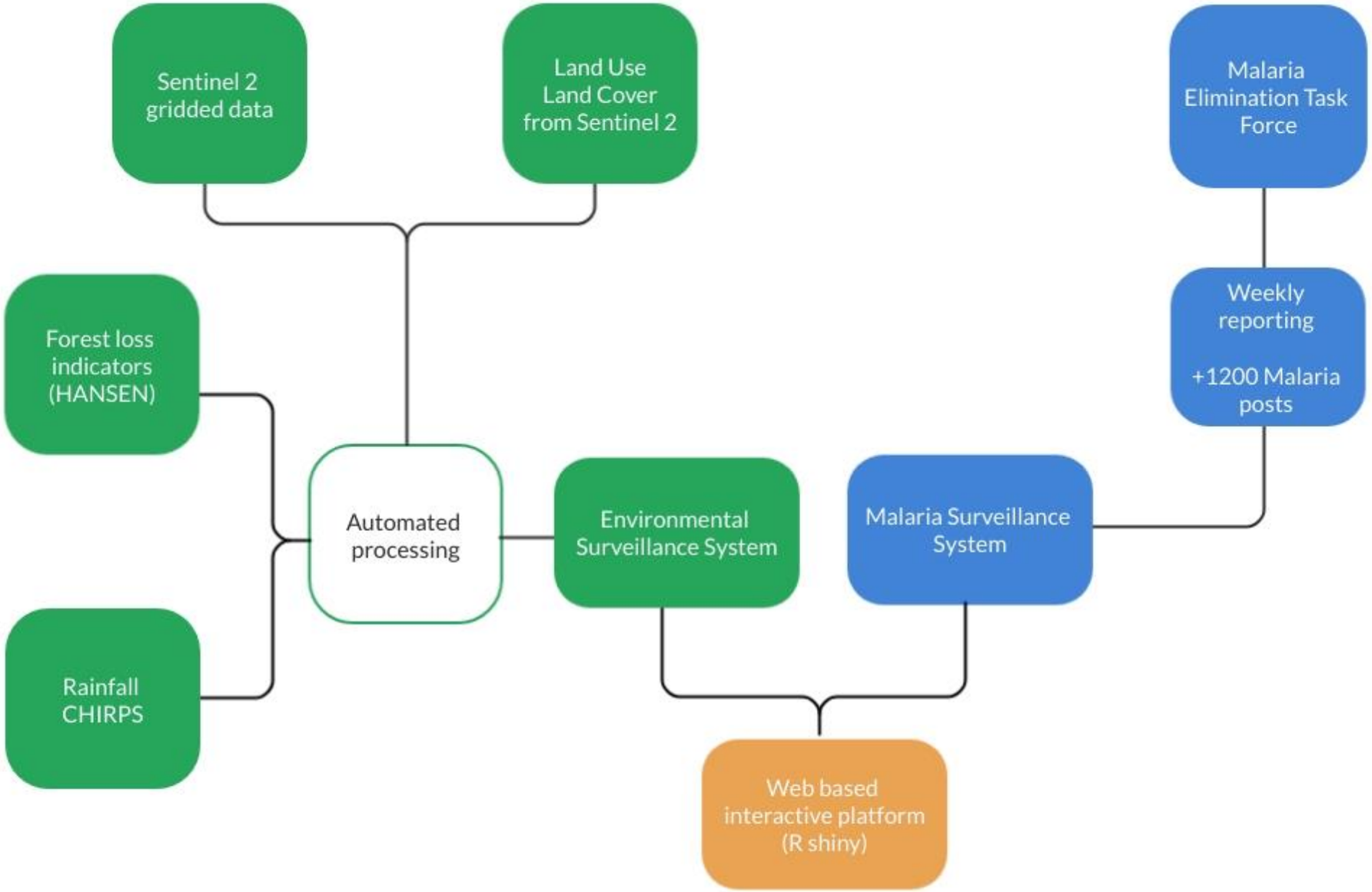

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Malaria Environmental Surveillance System

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

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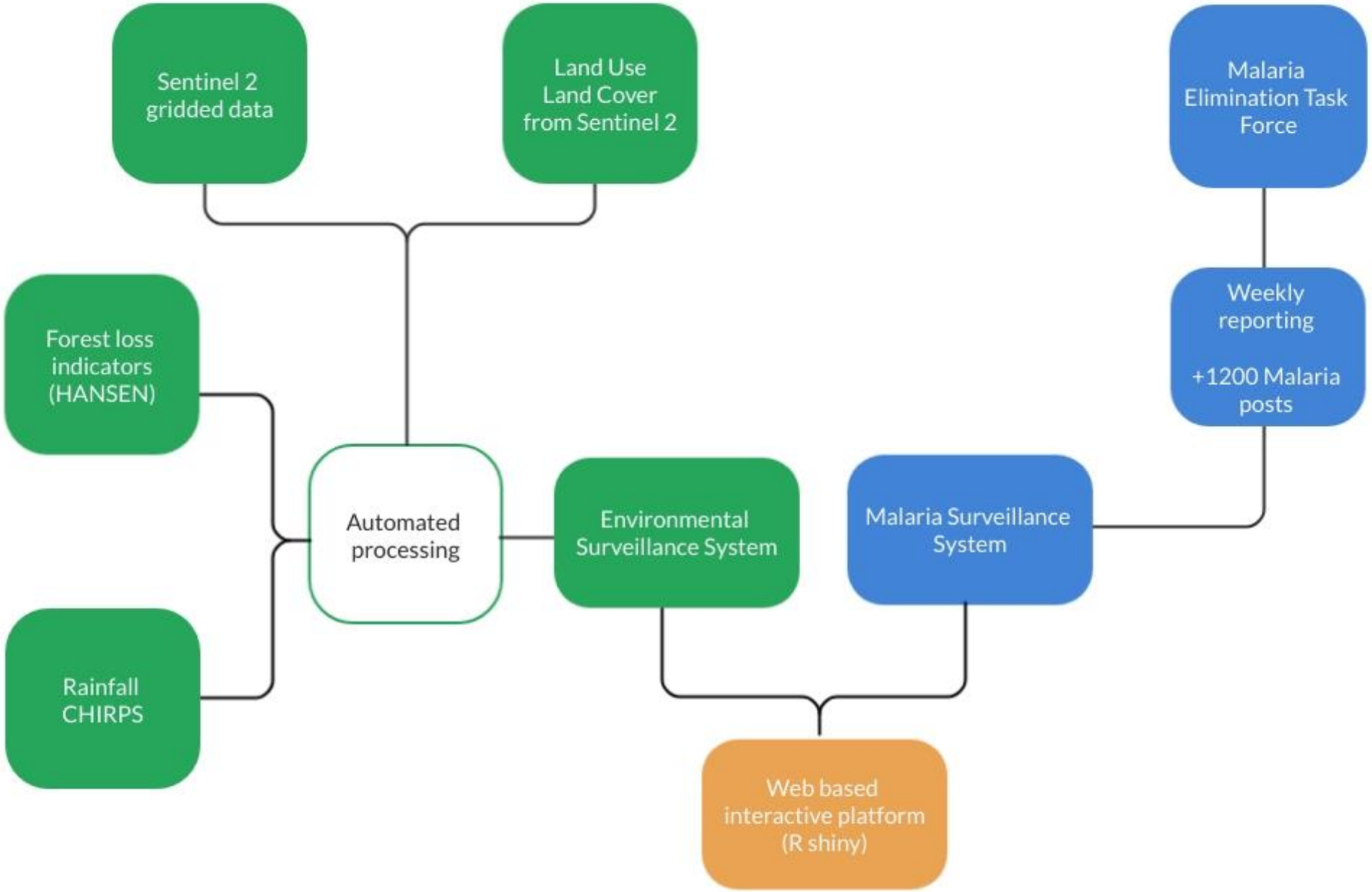


Malaria Environmental Surveillance System

sentinel-2

Sentinel 2 gridded data

Land Use Land Cover from Sentinel 2

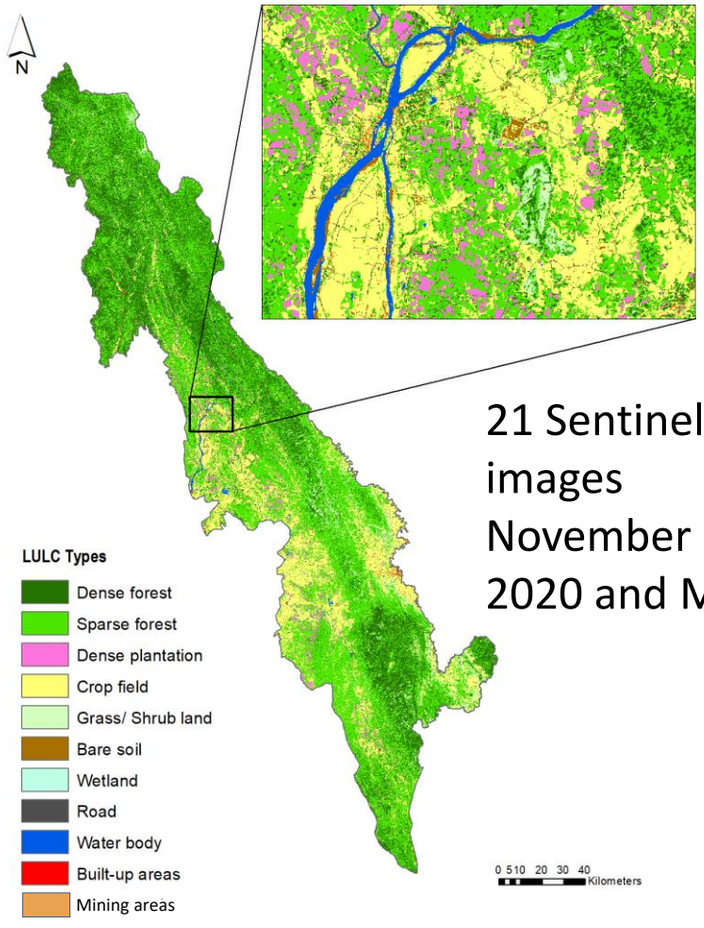
Forest loss indicators (HANSEN)

Automated processing

Environmental Surveillance System

Rainfall CHIRPS

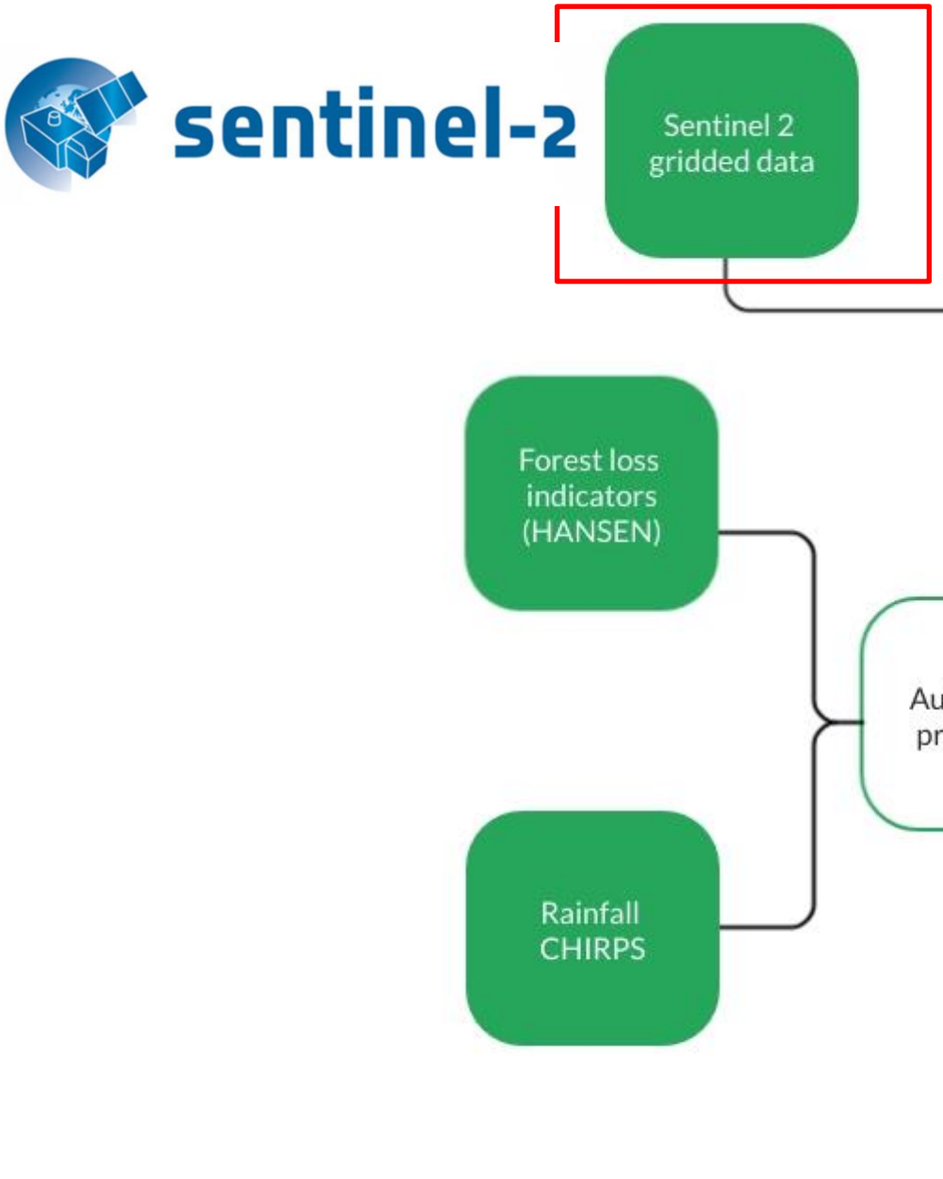
Web based interactive platform (R shiny)

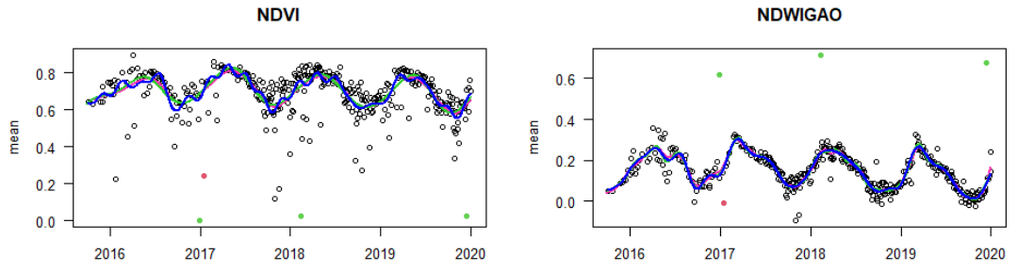


21 Sentinel-2 satellite images
November 2019, January 2020 and March 2020

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

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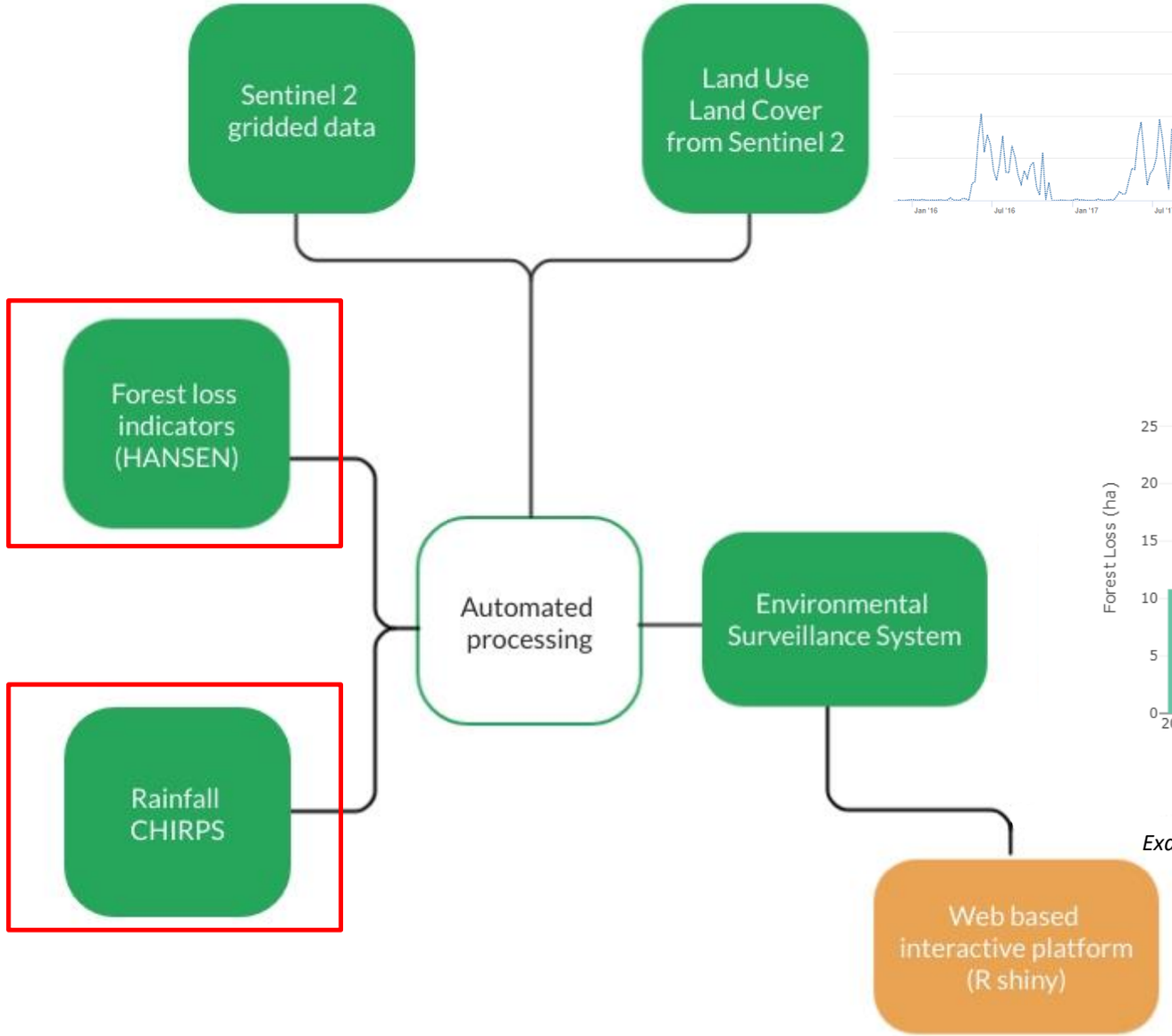
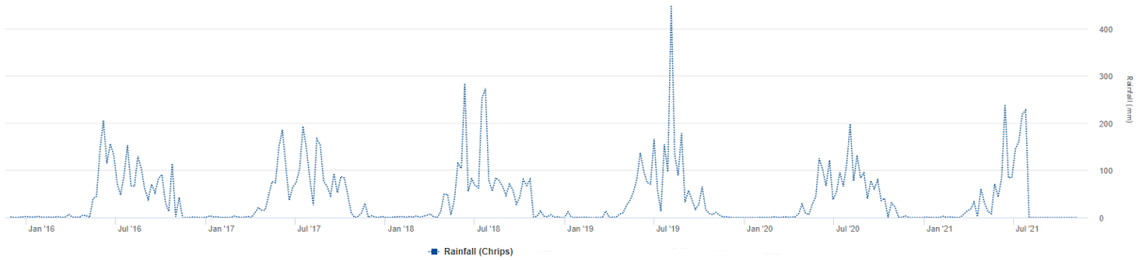
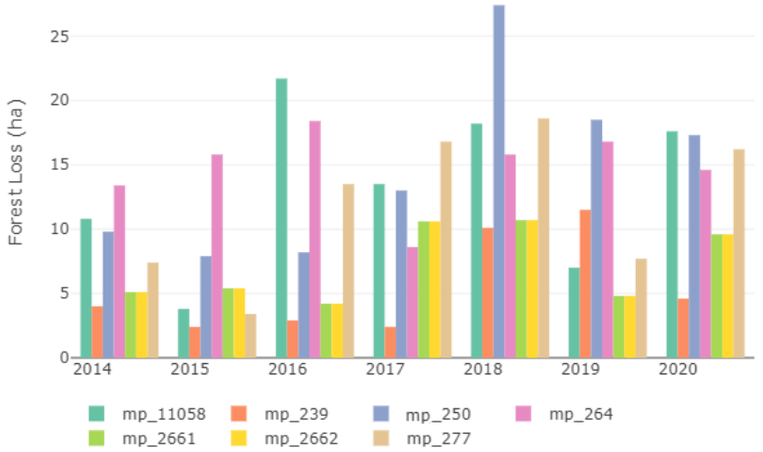




Weekly time series of Rainfall
CHIRPS v.2



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

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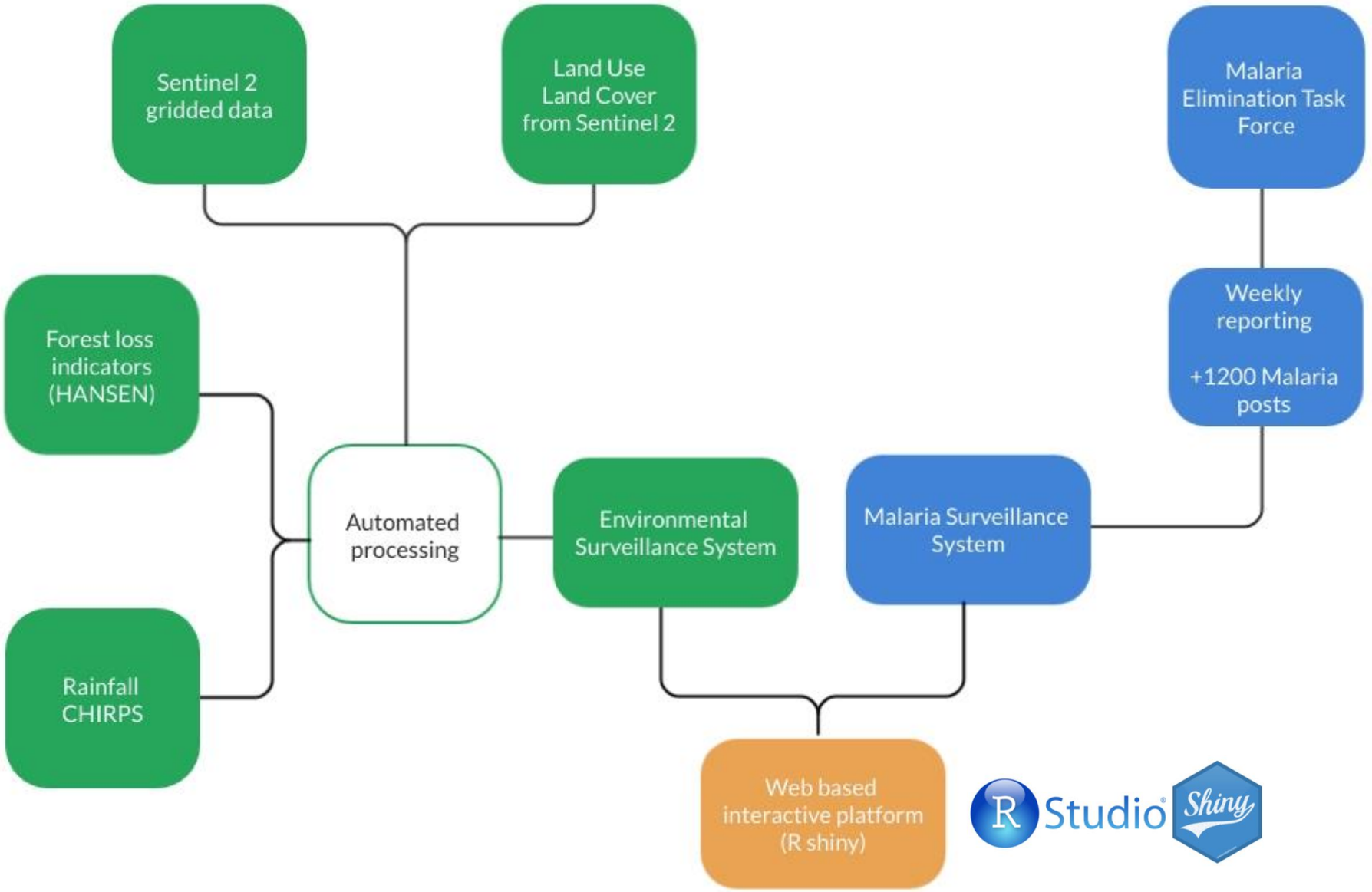


Summary | Environmental Time Series

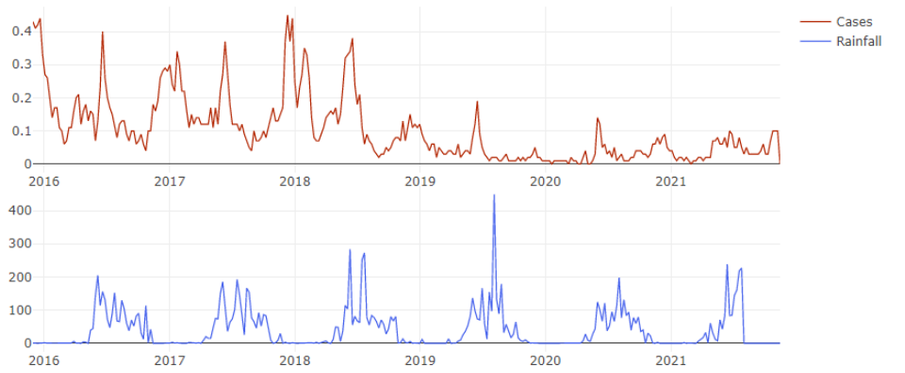
Press for instructions

Malaria species:

- (•) Falciparum
- ( ) Vivax

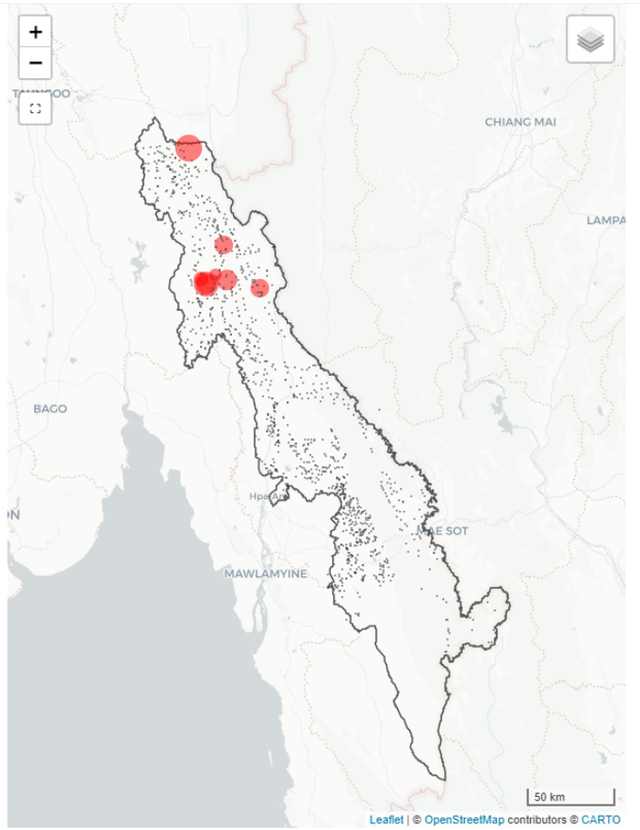
- (•) Malaria incidence
- ( ) Malaria cases

- [ ] Stacked or Grouped

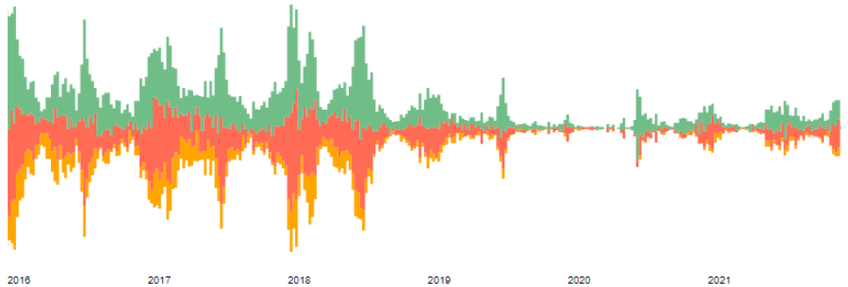


Search:

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%

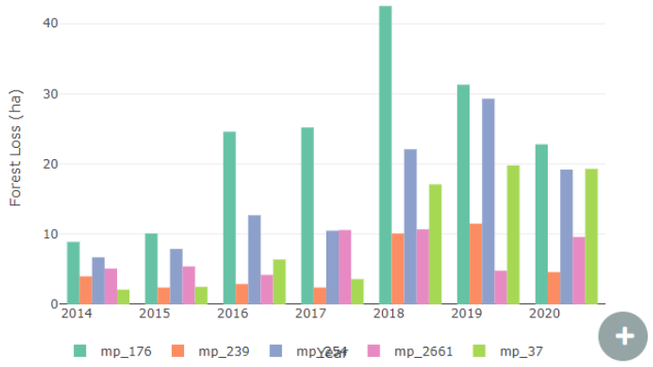


Age group



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

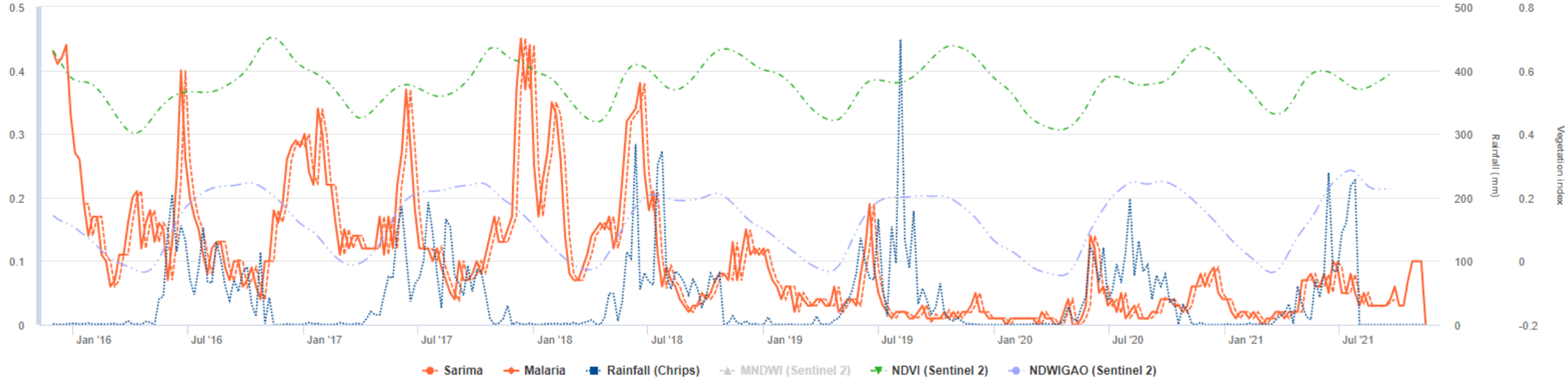
[2] 52

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)

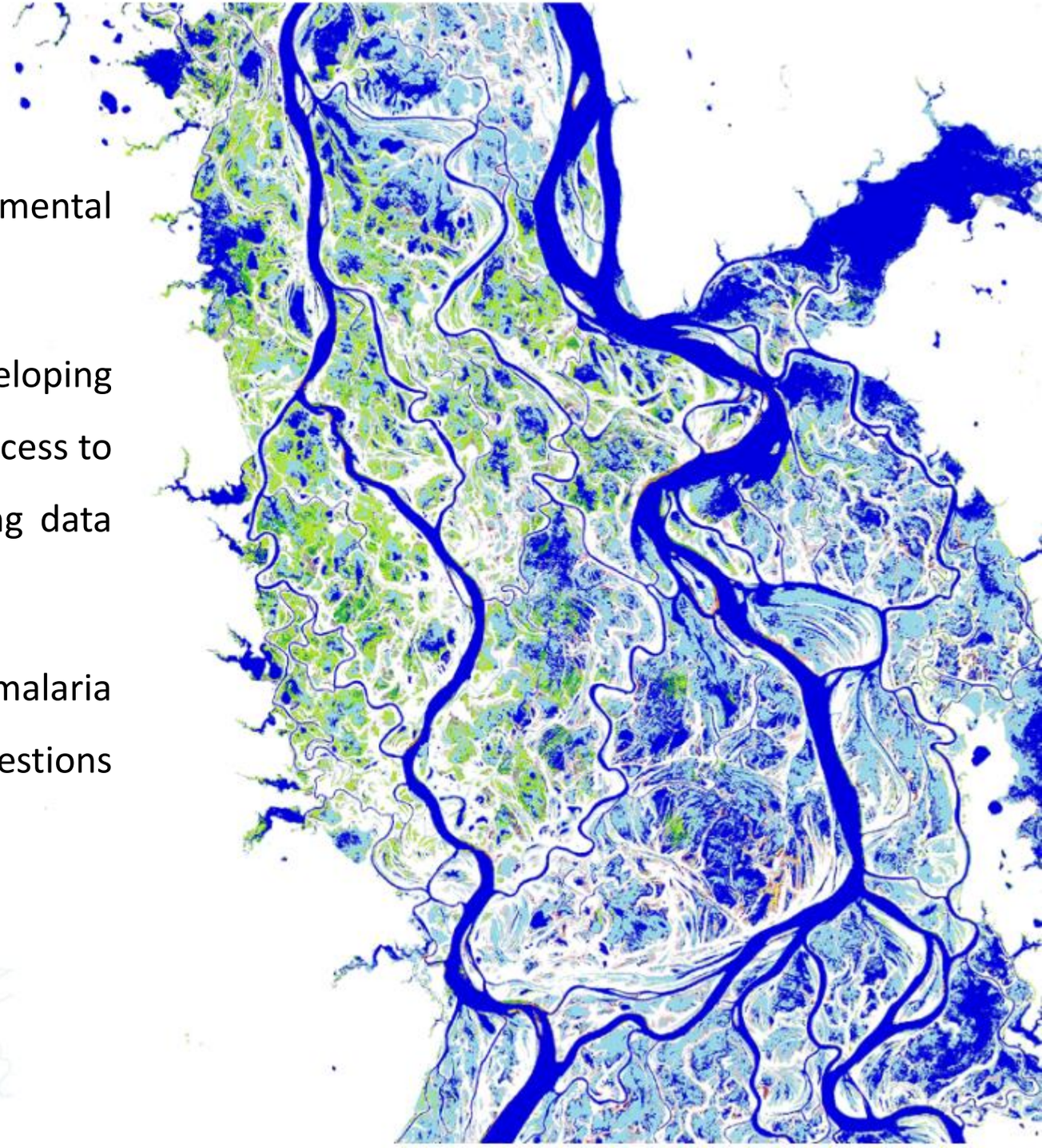
SARIMA AIC -1038.7

Search:

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

Conclusion

- Provides timely harmonized epidemiological and environmental data.
- Enable data sharing across different disciplines by developing tools to facilitate data retrieval and analysis to provide access to both epidemiological and environmental remote-sensing data for research and applications
- To facilitate more effective data-driven management of malaria interventions and provide practical examples and suggestions for use in other systems or settings.
- Technology transfer to Cambodia – KHEOBS laboratory



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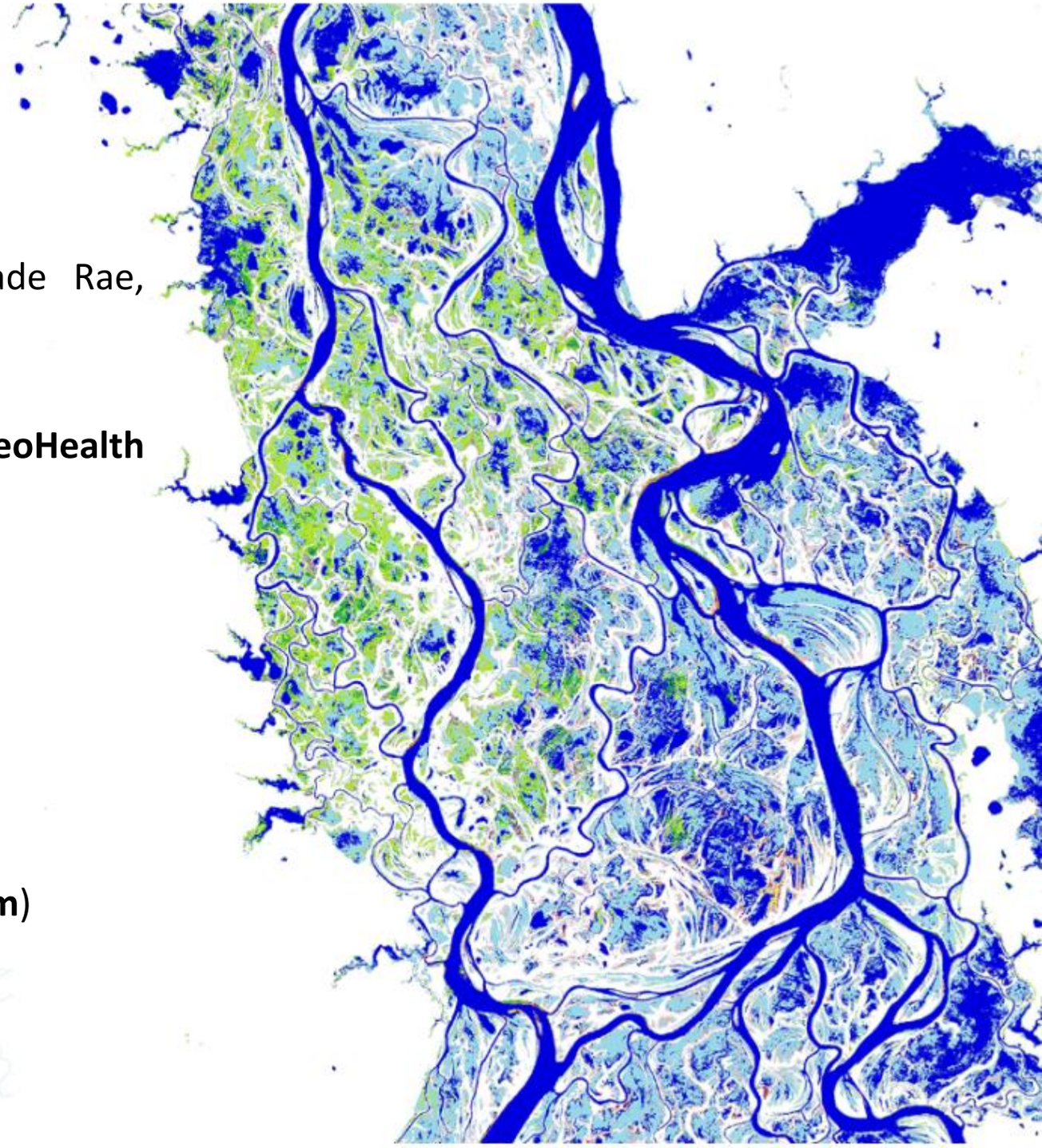
- Jordi Landier (**IRD, SESSTIM**)
- Sokeang Houen (**IRD-IPC GeoHealth Team**)
- Pascal Mouquet (**IRD**)
- Lucas Longour (**IRD- ESPACE-DEV, IRD-IPC GeoHealth Team**)
- Christophe Révillion, **Université de la Réunion** (France)



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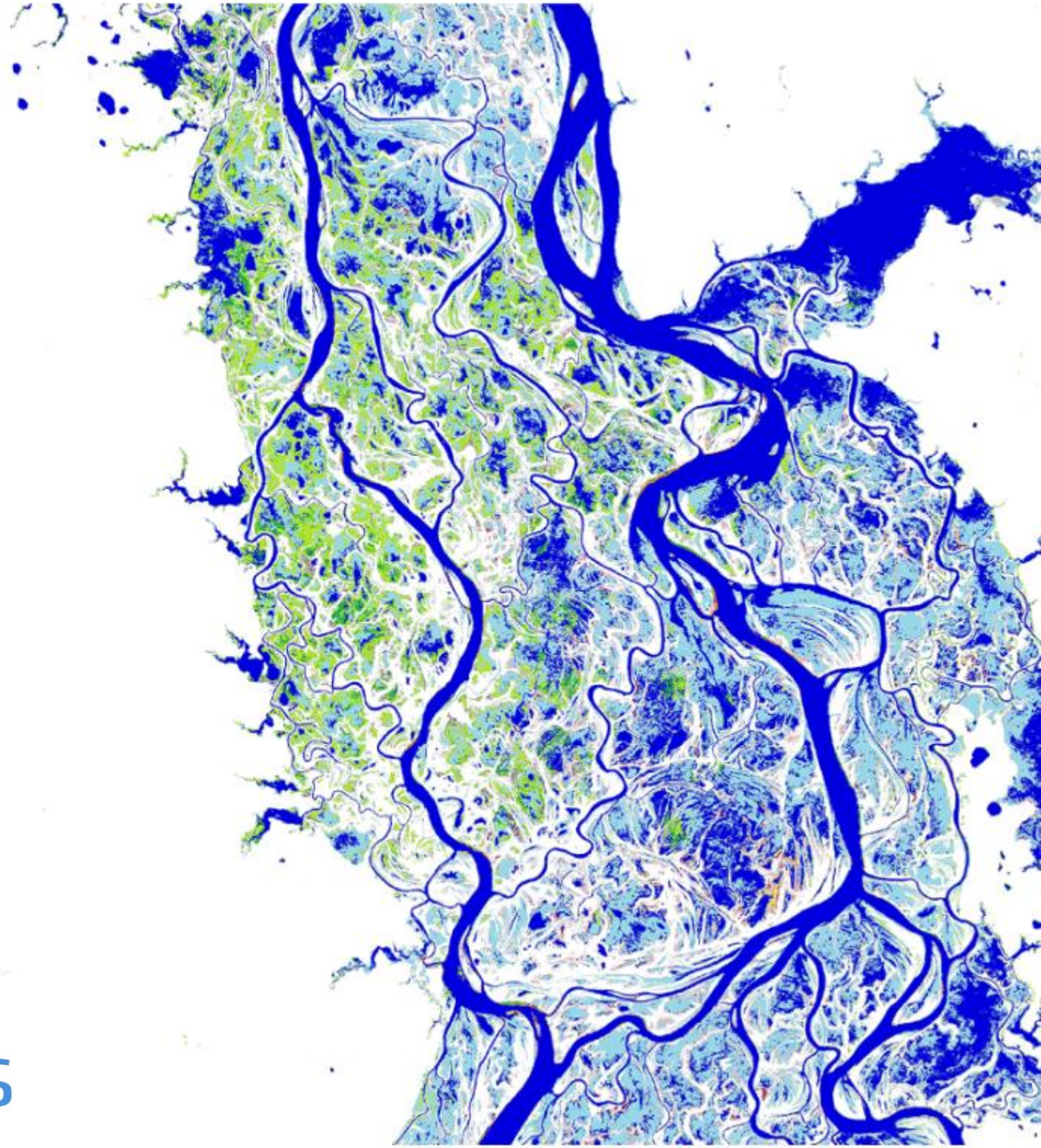
THANK YOU



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UNOPS