Malaria risk mapping in cross-border area between French Guiana and Brazil

Supporting malaria elimination plans

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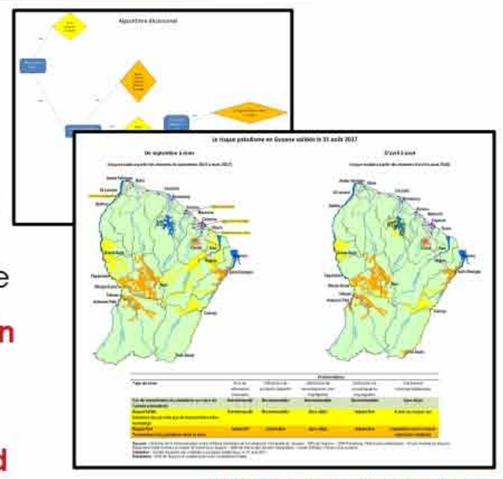
Background

- Brazil and French Guiana reaffirmed the **objective of malaria elimination** (new elimination plan in Brazil, planning elimination of *P. falciparum* and *P. vivax* up to 2030 and 2035, respectively MOH, 2022)
- Modelling/learning **approaches based on past reported cases** are promising Schincariol et al., 2020
- In cross-border areas, the **high spatial resolution and dynamic risk mapping based (notably) on remote sensing data would help targetting control and elimination actions** in space and time independently of the international limits
- **Risk mapping and knowledge formalization are used in Public Health**

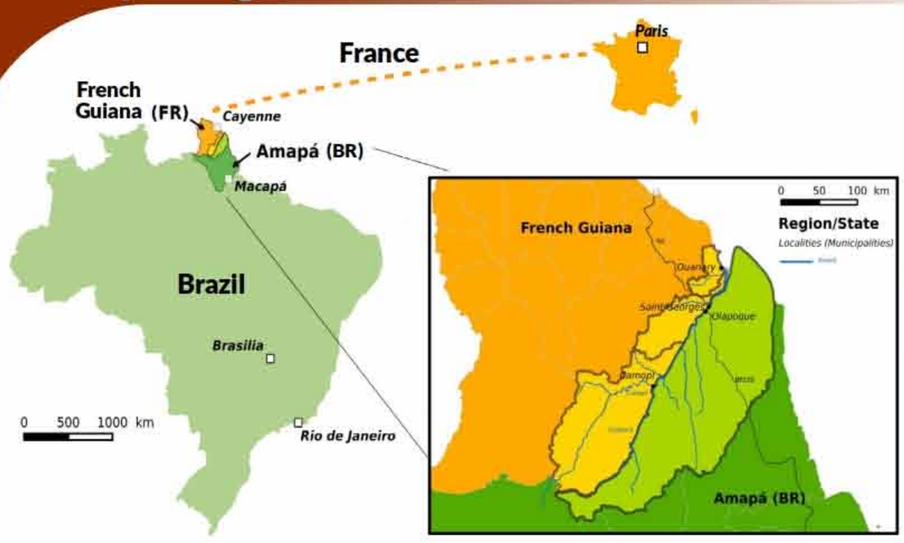
BUT

- **"Cross-border malaria [is] a major obstacle for malaria elimination"** Wangdi et al., 2015
- Pre-elimination phase means **very few cases** and potentially high impacts of control actions (**non-stationarity**) making such approaches inoperative
- Remotely sensed risk mapping is **not/rarely used in Public Health practice**
- knowledge and processing chains **should be formalized and standardized**, and **use of qualified data and indicators should be enhanced**, to ensure greater objectivity and reproducibility



ARS-Guyane, Kwata, 2017

Study Region



Objectives

Mapping of malaria risks for an actual use in public health and based on remotely sensed (RS) data, for supporting:

- Targetting of control/elimination actions
- Prevention/prevision of malaria reintroduction

(NB: the idea is to support, in partnership! not substitute to current Public health approach!)

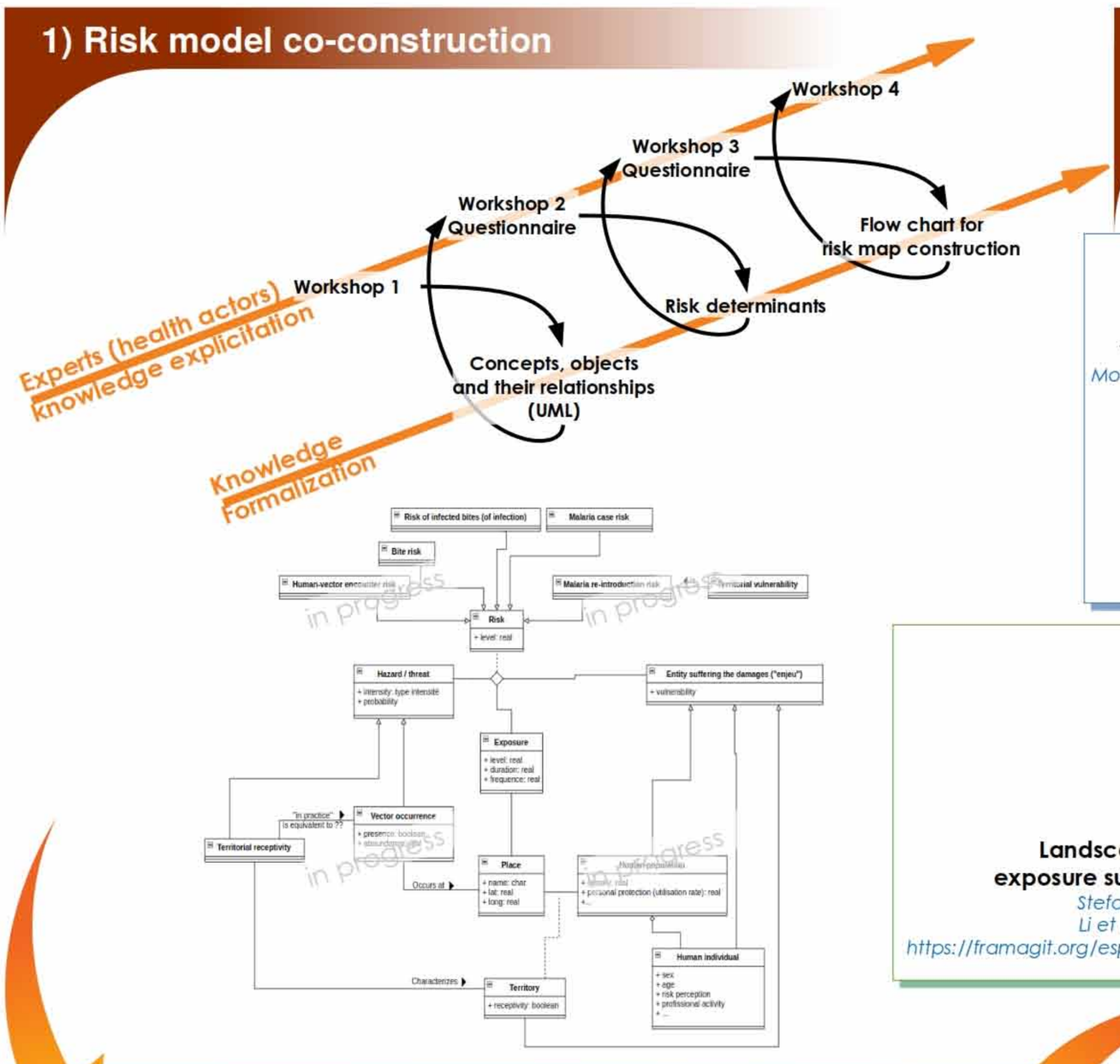
Method

1) Elaboration of conceptual models of risks

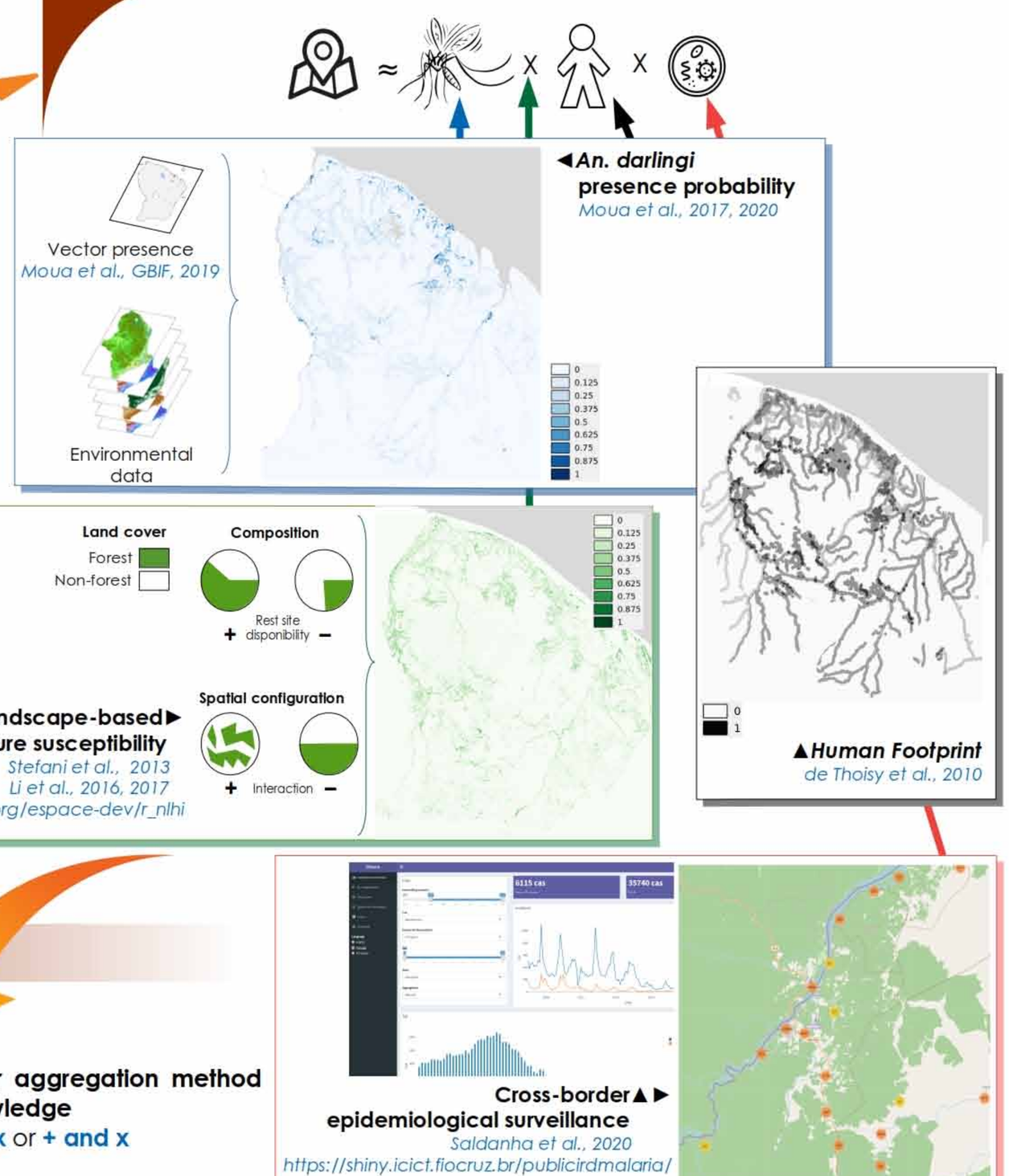
- **Co-constructed** by **1) researchers** in RS and data/model sciences **and 2) public health actors**
- **Adopting international standards** (WHO recommendations on risk stratification: vocabulary; strata definition)

2) Implementation of the models based on objective, qualified and up to date data and indicators

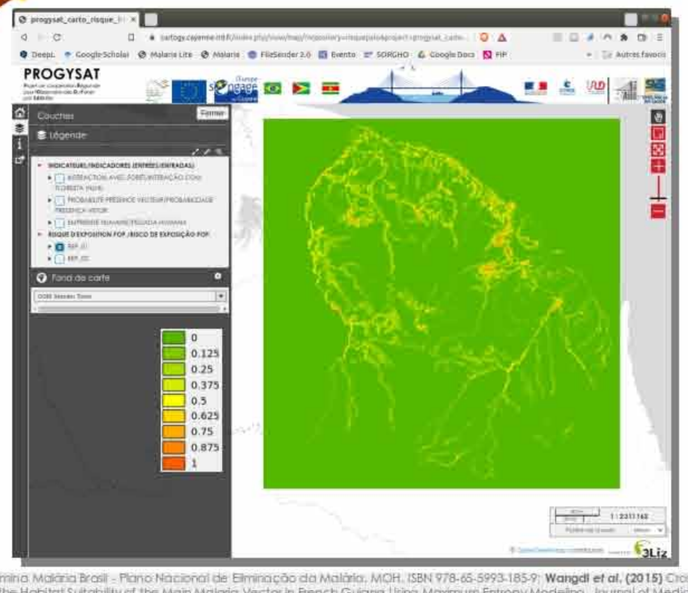
1) Risk model co-construction



2) Indicator production



Preliminary results & Perspectives



- **Specification of the indicator aggregation method based on the formalized knowledge**
  - aggregation operator: **+** or **x** or **+ and x**
  - Indicator weights
- **Result evaluation** (Workshop 4; capacity of predict case occurrence, based on historical data)
- **Result dissemination & promotion** intended to researchers, public health actors and general public

◄***Risk (in population) of exposure to the main malaria vector*** *(An. Darlingi) (Prototype/Proof of concept)*
https://cartogy.cayenne.ird.fr/index.php/view/map/?repository=risquepalu&project=progysat_carto_risque_lizmap

Cross-border▲► epidemiological surveillance
Saldanha et al., 2020
https://shiny.icict.fiocruz.br/publicirdmalaria/

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MOH (2022) Eliminia. Malária Brasil – Plano Nacional de Eliminação da Malária. MOH. ISBN 978-65-5993-185-9; **Wangdi et al. (2015)** Cross-border malaria: A major obstacle for malaria elimination. Adv. Parasitol. 2015, 89, 79–107; **Moua et al. (2019)** A database of Anopheles (Diptera, Culicidae): historical presence records in French Guiana and in the state of Amapá, in South America. GBIF. DOI: 10.15468/x4h0lu; **Moua et al. (2016)** Distribution of the Habitat Suitability of the Main Malaria Vector in French Guiana Using Maximum Entropy Modeling. Journal of Medical Entomology. DOI: 10.1093/jme/tjw199; **Moua et al. (2020)** Correcting the effect of sampling bias in species distribution modeling – A new method in the case of a low number of presence data. Ecological Informatics. 57. DOI: 10.1016/j.ecoinf.2020.101086; **Stefani et al. (2013)** Land cover, land use and malaria in the Amazon: a systematic literature review of studies using remotely sensed data. Malaria Journal. 12. 192. DOI: 10.1186/1475-2875-12-192; **Li et al. (2017)** Regionalization of a Landscape-Based Hazard Index of Malaria Transmission: An Example of the State of Amapa, Brazil. Data. 2. 37. DOI: 10.3390/data2040037; **Li et al. (2016)** Mapping a Knowledge-Based Malaria Hazard Index Related to Landscape Using Remote Sensing: Application to the Cross-Border Area between French Guiana and Brazil. Remote Sensing. 8. 319. DOI: 10.3390/rs8040319; **de Thoisy et al. (2010)** Rapid evaluation of threats to biodiversity: human footprint score and large vertebrate species responses in French Guiana. Biodiversity and Conservation. 19. 1567–1584. DOI: 10.1007/s10531-010-9787-z; **Saldanha et al. (2020)** Contributing to Elimination of Cross-Border Malaria Through a Standardized Solution for Case Surveillance, Data Sharing, and Data Interpretation: Development of a Cross-Border Monitoring System. JMIR Public Health and Surveillance. 6. DOI: 10.2196/15409; **Schincariol et al. (2021)** Forecasting cross-border malaria case number: towards an early warning system to support malaria elimination plans. In ITISE'2021. Presented at the 7th International conference on Time Series and Forecasting. Spain.