Malaria risk mapping

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Malaria elimination

no autochtonous case for three consecutive years + …

- **French guiana :** Elimination objective reaffirmed by French government
- **Brazil :** New elimination plane of the MH

  (*P. falciparum* before 2030, *P. vivax* before 2035)
- **Suriname :** Malaria elimination program of the MH

Decreased endemic malaria in Suriname: moving towards elimination

Edward D. van Eer[1*], Gustavo Bretas[2] and Hélène Hiwat[3]

[Van Eer et al., 2018]

From control to elimination

- Strengthen **diagnosis** and **treatment,** (cross-border) **surveillance, vector control, ...**
- Towards more **targeted actions**
  - In time
  - In space
  - Towards specific populations
- Implement methods and tools for **re-introduction detection/prevention**

Main objective of the project

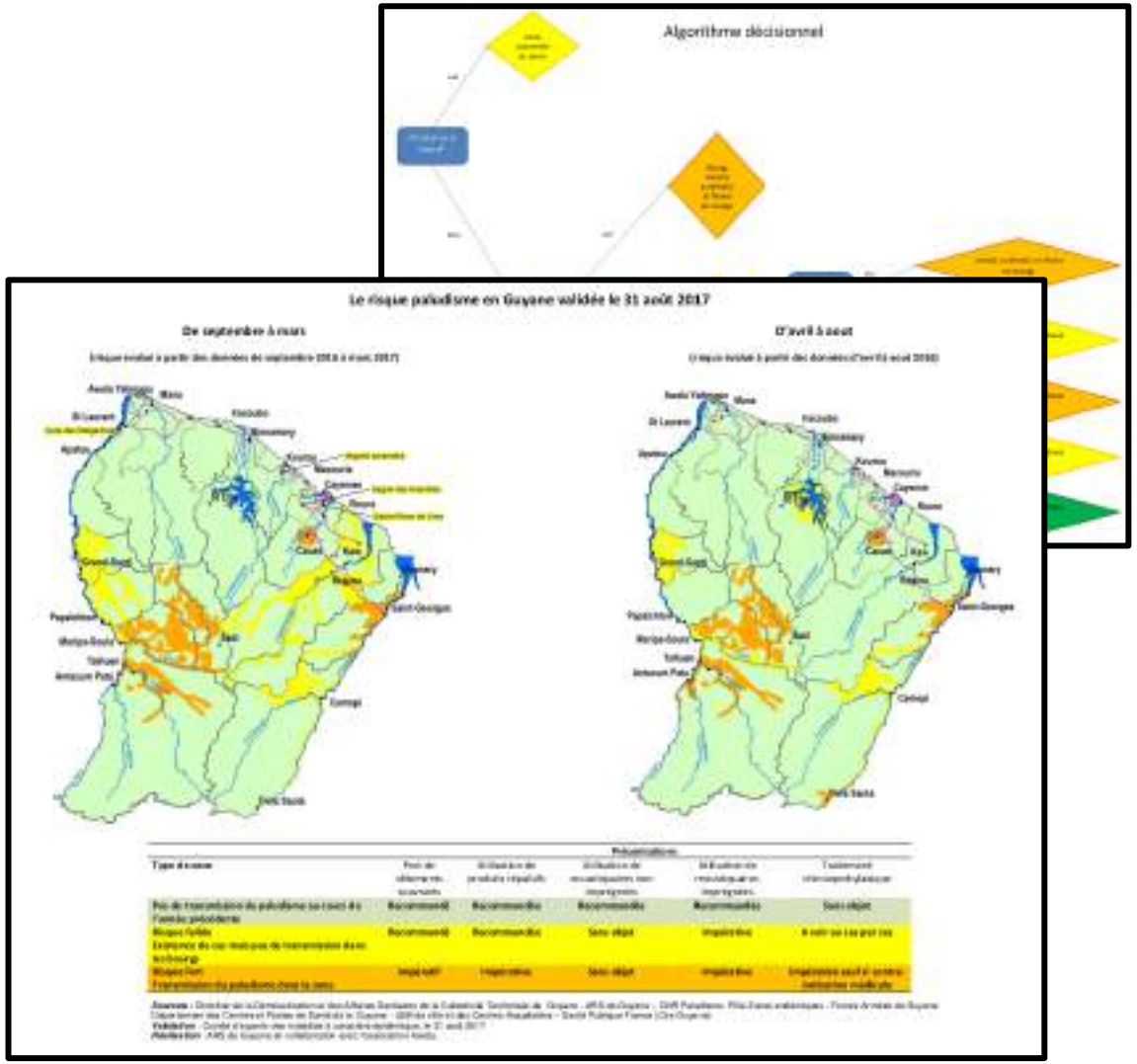
Mapping of malaria risks (risk stratification) for an actual use in public health, based on remotly sensed data

- Control/elimination action targetting
- Reintroduction prevention/prevision

Extend the existing partnership between Brazil and France to Suriname

Risk mapping

- Not new ***as an application of remote sensing*** … but actually **not/rarely used in public health**
  - Does not meet the needs (Information, resolutions, ...)
  - Difficulties to understand/interpret the results
- **Used in public health**



[ARS-Guyane, Kwata, 2017]

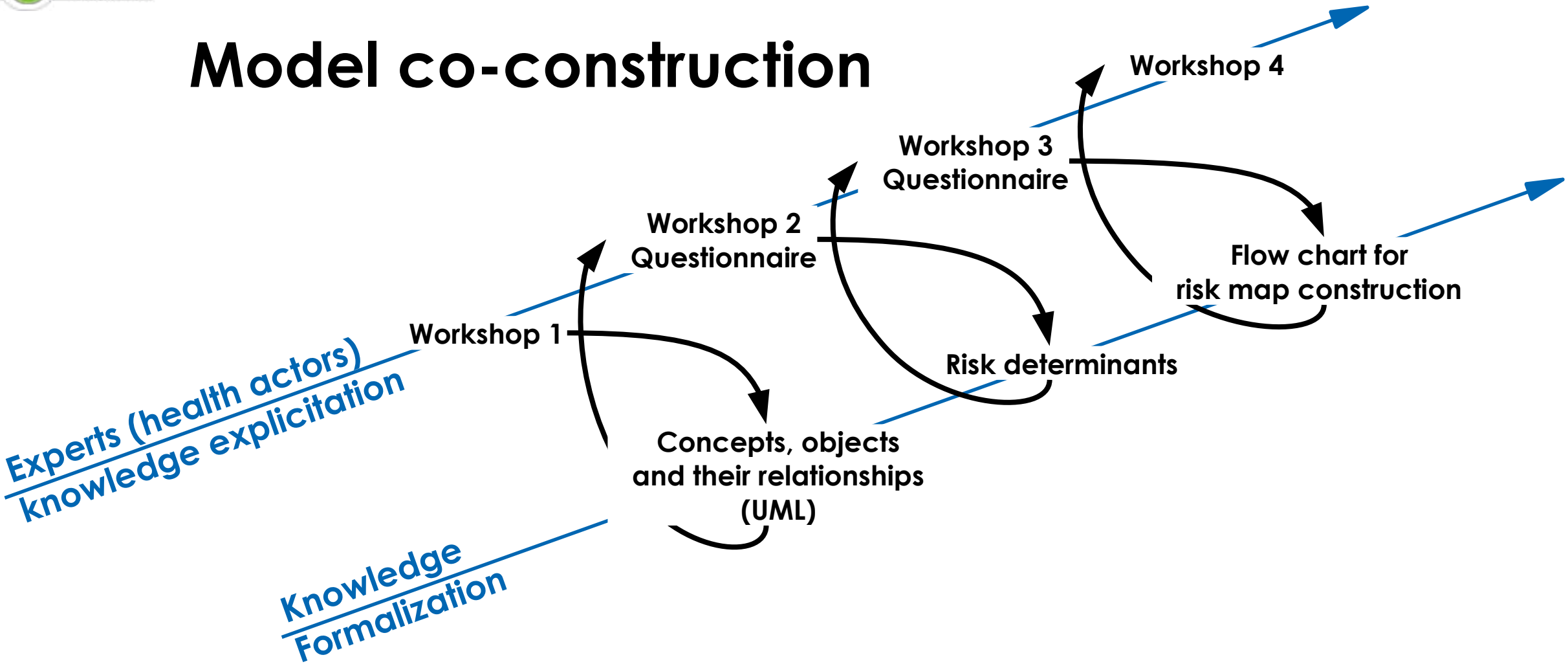
Specific objectives

- **Co-construction of the conceptuel risk models**
- **Implementation of the models**
  - Collection/production of objective, qualified and up to date data and indicators
  - Risk mapping by indicator combination

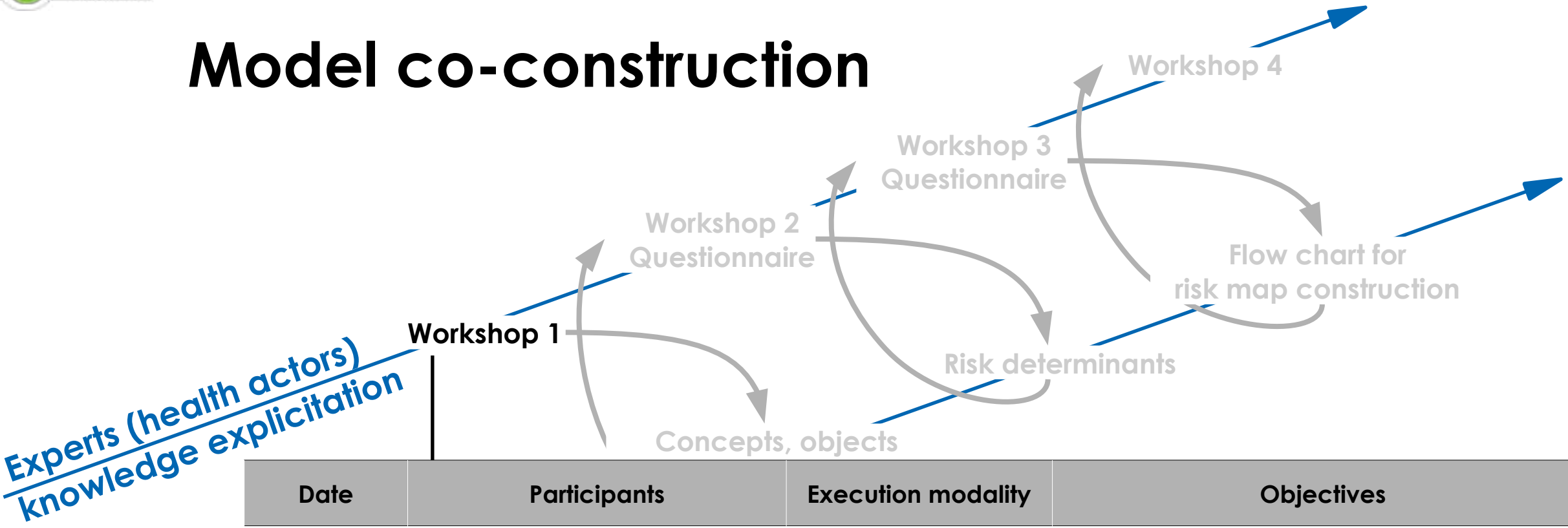
Co-construction of the conceptuel risk models

- **Method and first results**
- **Next steps**

Model co-construction



Model co-construction



Date	Participants	Execution modality	Objectives
07/02/2022	French Guiana health actors: SPF/CIRE-Guyane, CTG/LAV, IPG/Entomo., IPG/CNR Palu., CHC, CNES	In person, 2 sessions of 2 hours	Inventory of actors' needs and of existing risks How risks are related?
13/04/2022 and 14/04/2022	Brasilian actors: SVS-AP, IEPA, UnB, FIOCRUZ, UNIFAP, …	Remoto, 2 sessões de 2 horas, em português	

Model co-construction

Workshop 1

Workshop 2
Questionnaire

Workshop 3
Questionnaire

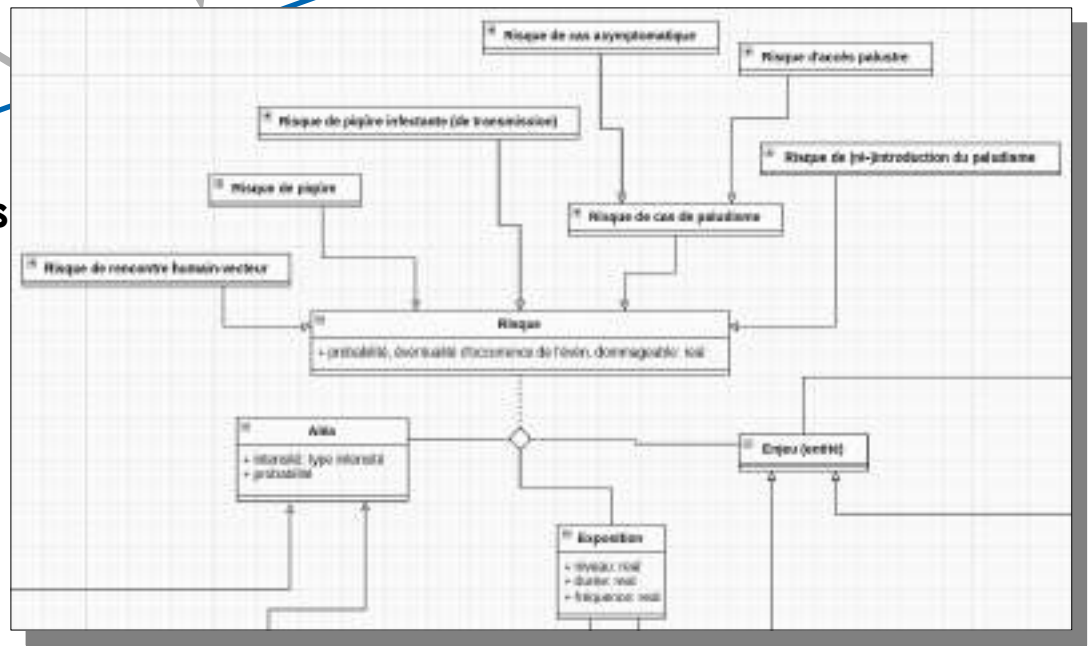
Workshop 4

Flow chart for
risk map construction

Experts (health actors)
knowledge explicitation

Concepts, objects
and their relationships
(UML)

Knowledge
Formalization



Next steps

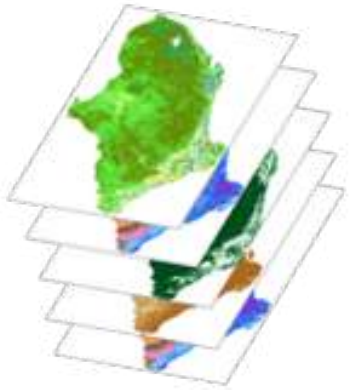
	Date	Participants	Execution modalities	Objectives	Status
1	07/02/2022	French Guiana health actors: SPF/CIRE-Guyane, CTG/LAV, IPG/Entomo., IPG/CNR Palu., CHC, CNES	In person, 2 sessions of 2 hours	Survey of actors' needs, of risks that exist, how risks are related, which actors and actions associated with each type of risk	**Done**
	13/04/2022 e 14/04/2022	Brasilian actors: SVS-AP, IEPA, UnB, FIOCRUZ, UNIFAP, …	Remote meeting, 2 sessions of 2 hours		
2	Nov./Dec. 2022	All actors	To be defined	Risk model discussion; presentation/discussion of the questionnaire on risk factors	
3	Dec./Jan. 2023	All actors	To be defined	Feedbacks on the results of the questionnaire on the factors; Discussion on the factors and their relationships with the risks; presentation of the questionnaire on risk components weighting	
4	March-June 2023	All actors	To be defined	Presentation and discussion of results; presentation of the platform for result dissemination; Perspectives	

Tools for **model implementation**

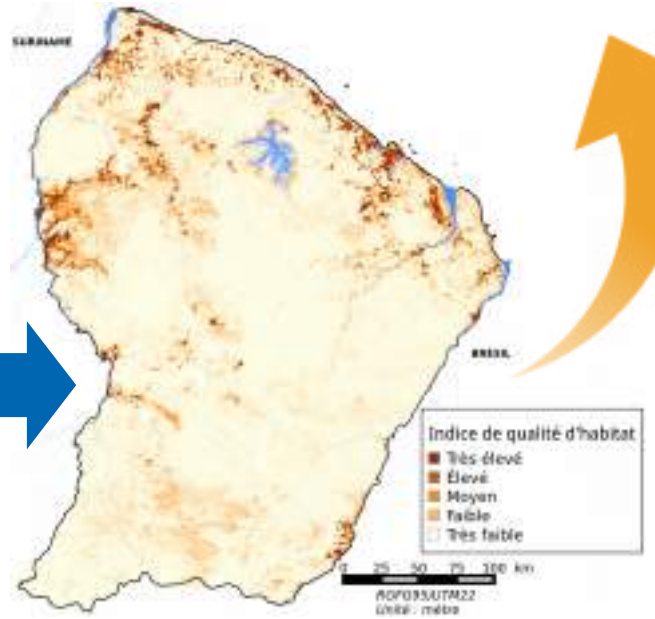
- **Indicator production and aggregation, dissemination**
- **Next steps**

Vector data & indicators

Vector presence



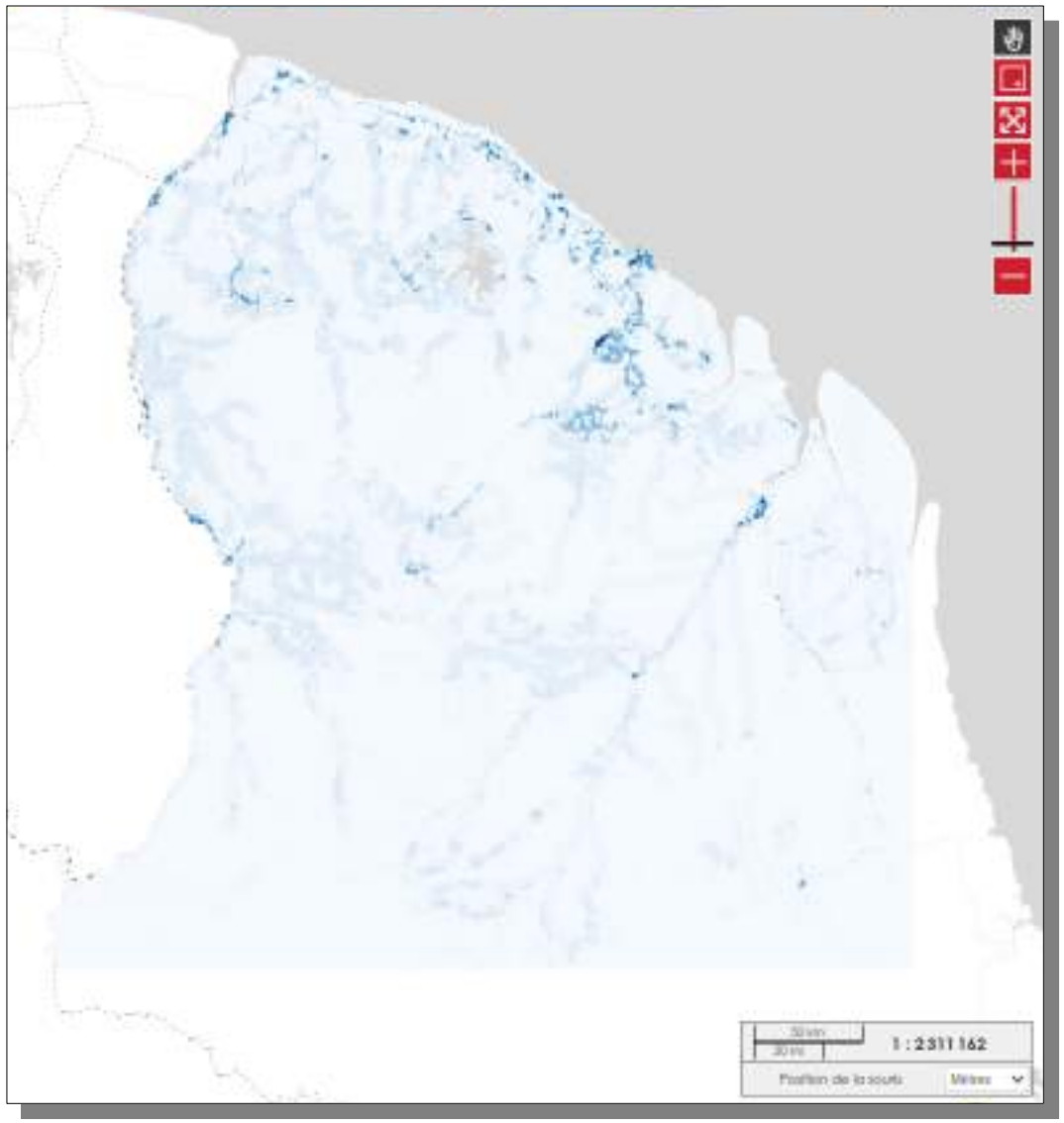
Environmental Data



An. darlingi
presence probability

[Moua et al., J. Med. Entomo., 2017
Moua et al., GBIF, 2019
Moua et al., Ecol. Informatics, 2020]

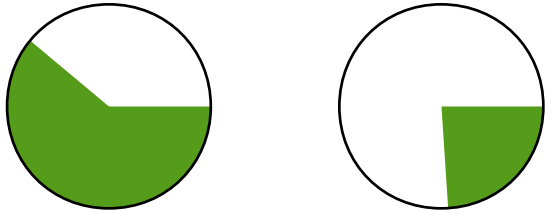
Vector data & indicators



An. darlingi
presence probability

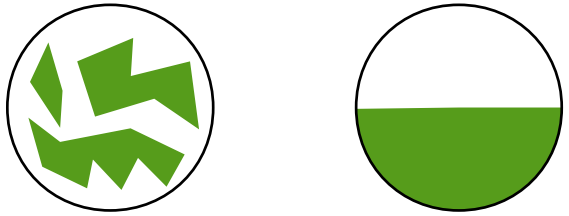
Exposition data & indicators

Composition

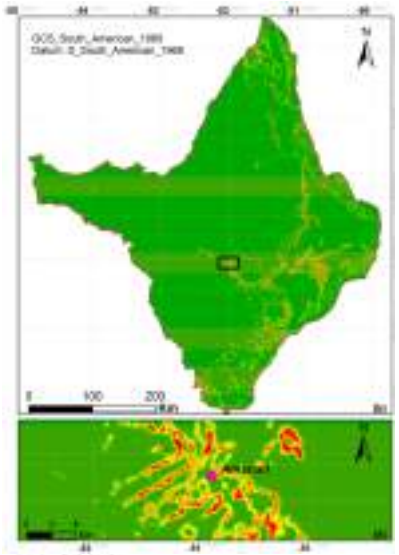


Rest site
\+ disponibility −

Spatial configuration



\+ Interaction −

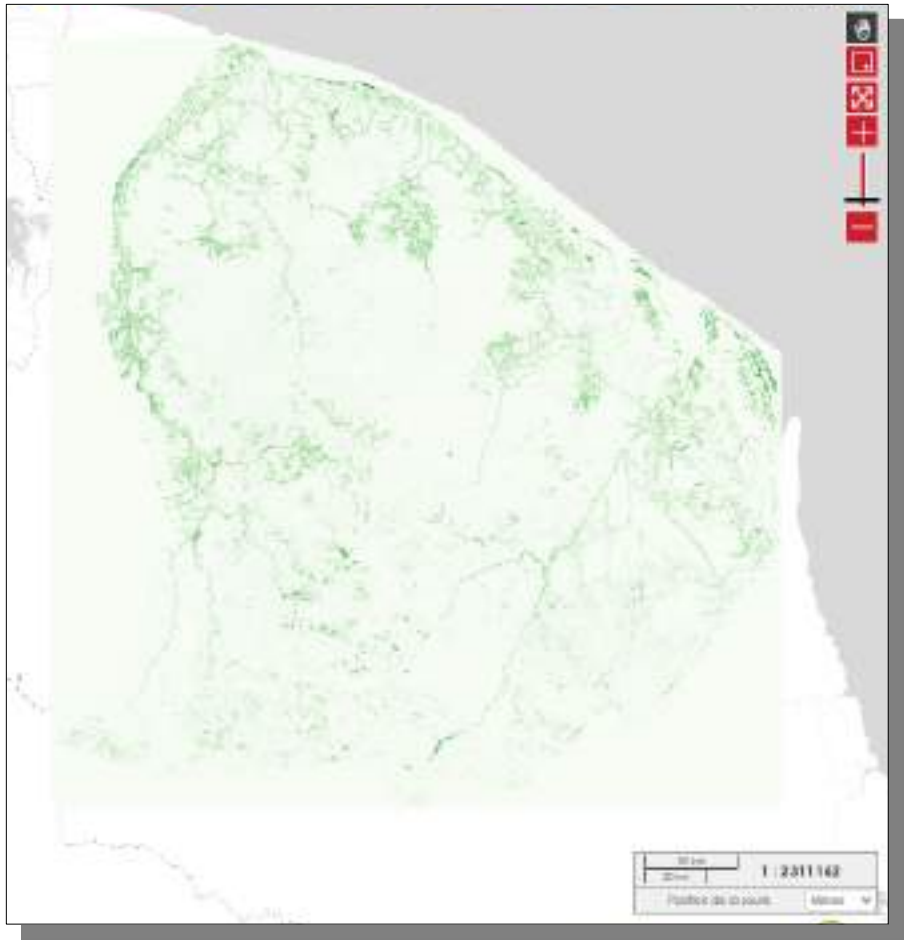


Landscape-based exposure susceptibility

[Stefani et al., Malaria Journal, 2013
Li et al., Remote sensing, 2016, 2017]
https://framagit.org/espace-dev/r_nlhi

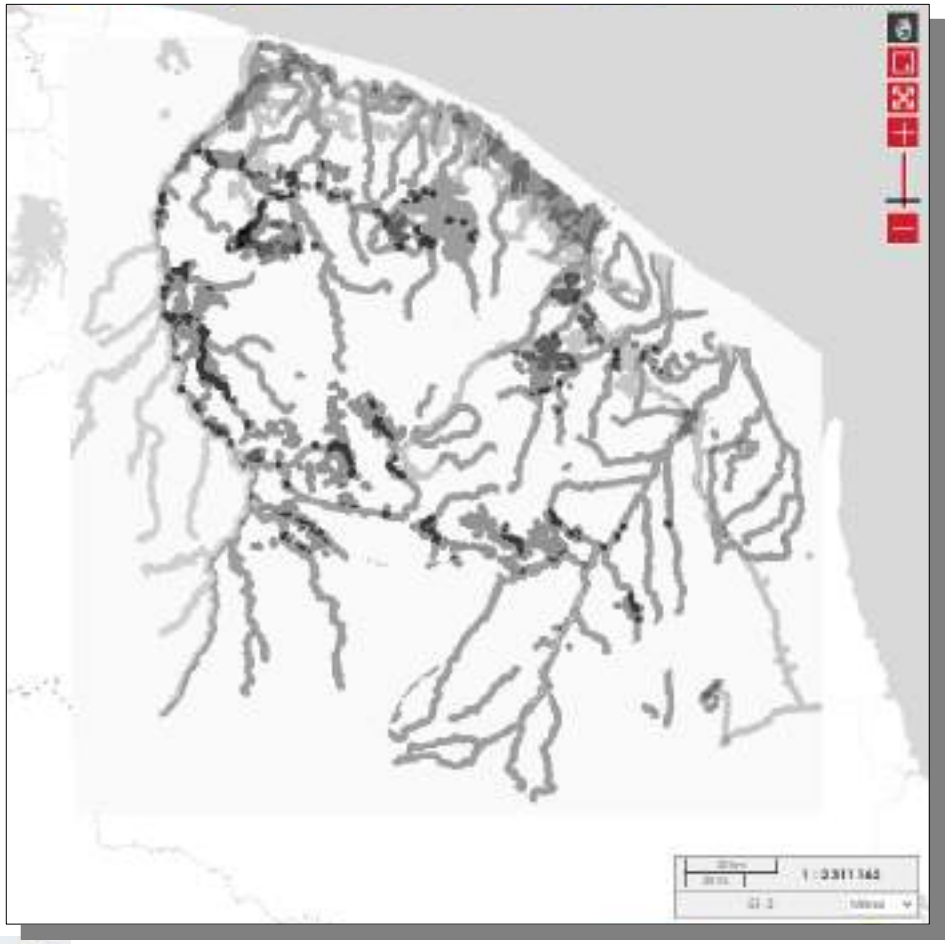
Exposition data & indicators

Landscape-based exposition susceptibility



Human presence and activity

(based on : Sanderson et al., 2002, de Thoisy et al., 2010 ; NASA)

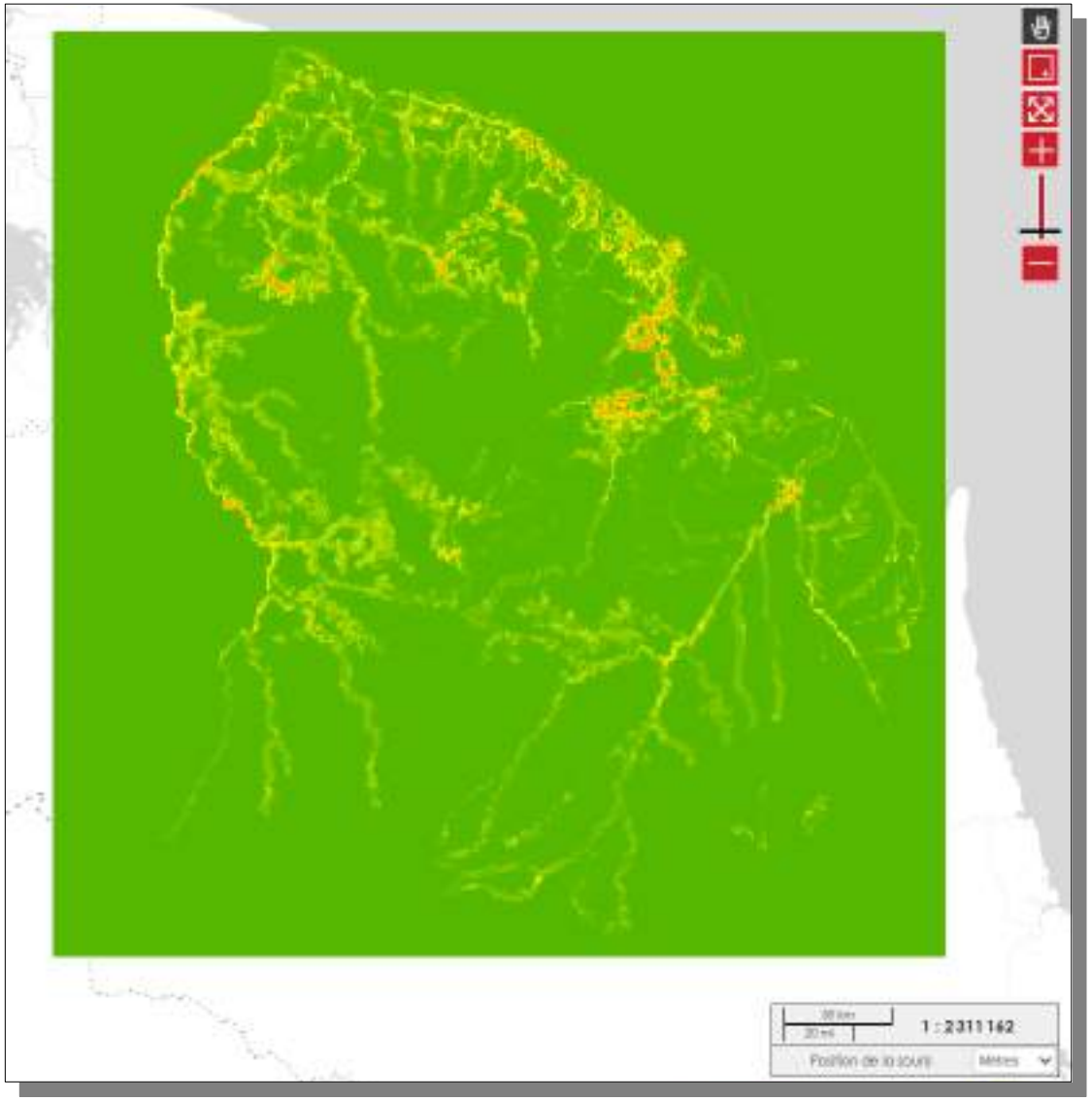


Risk mapping

Prototype/Feasibility study

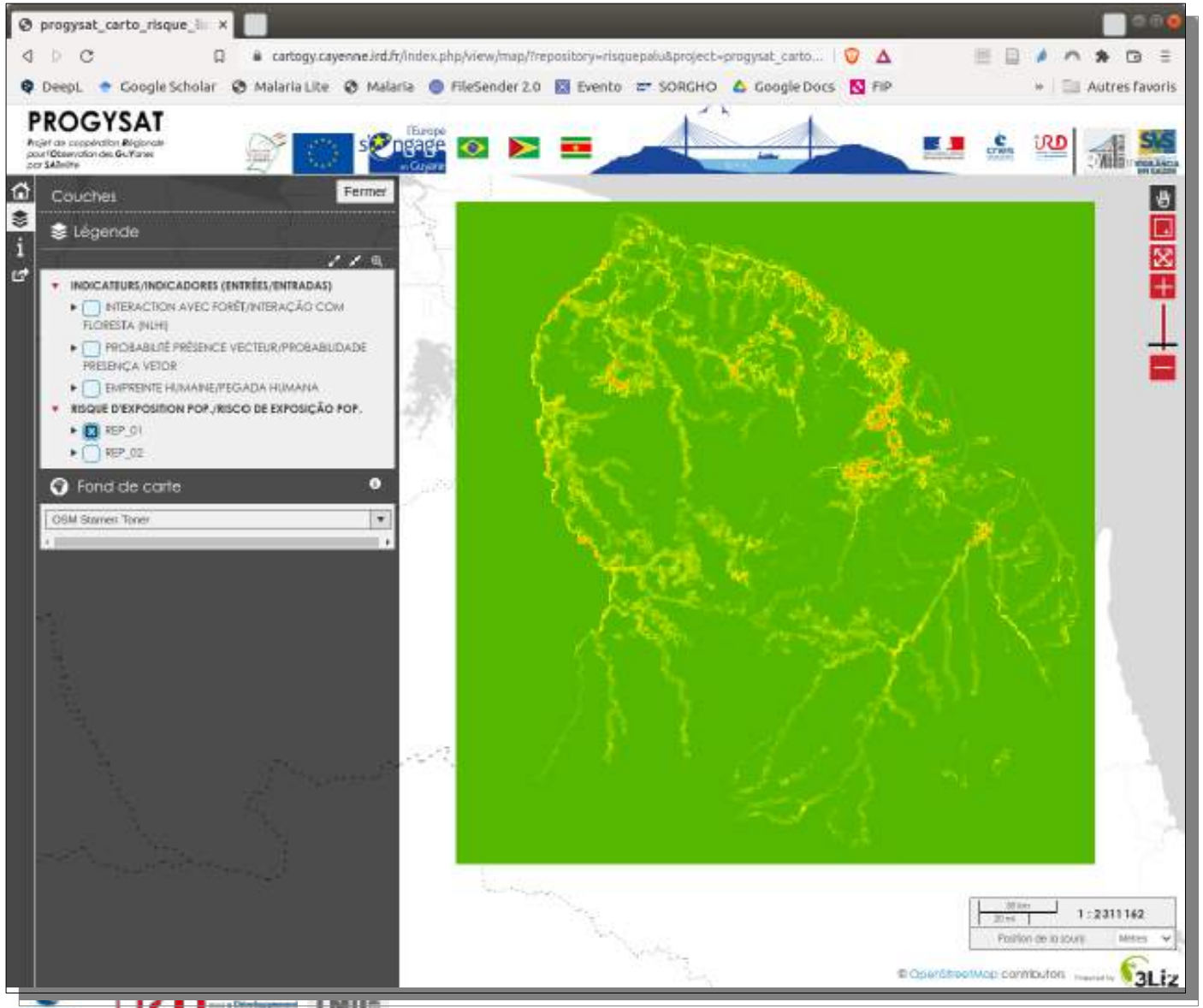
Risk of exposure to vector (in population)

Multiplicative indicator combination with uniform weighting



Transfer, dissemination of data and knowledge

https://cartogy.cayenne.ird.fr/index.php/view/map/?repository=risquepalu&project=progysat_carto_risque_lizmap



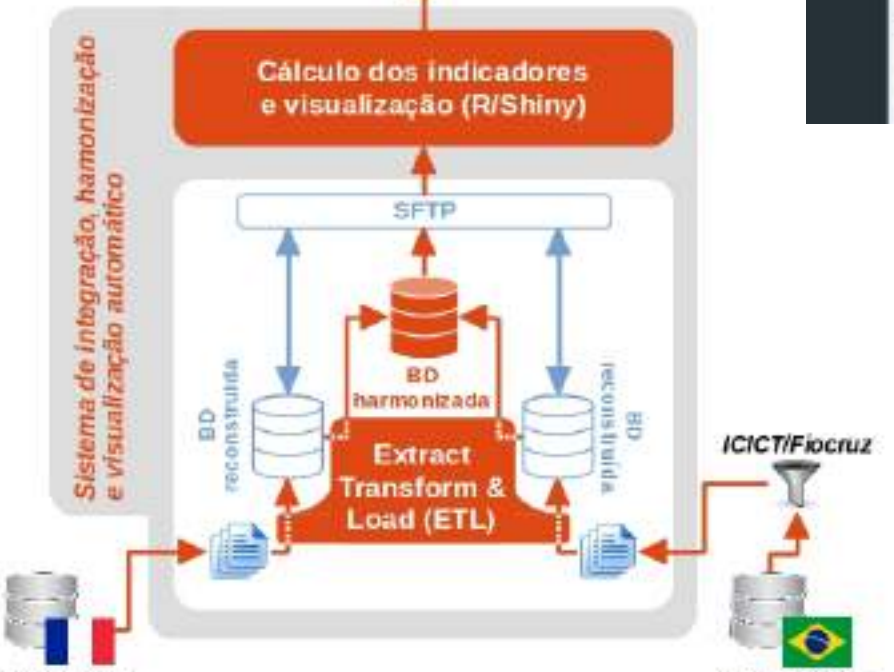
Building tools for **model implementation**

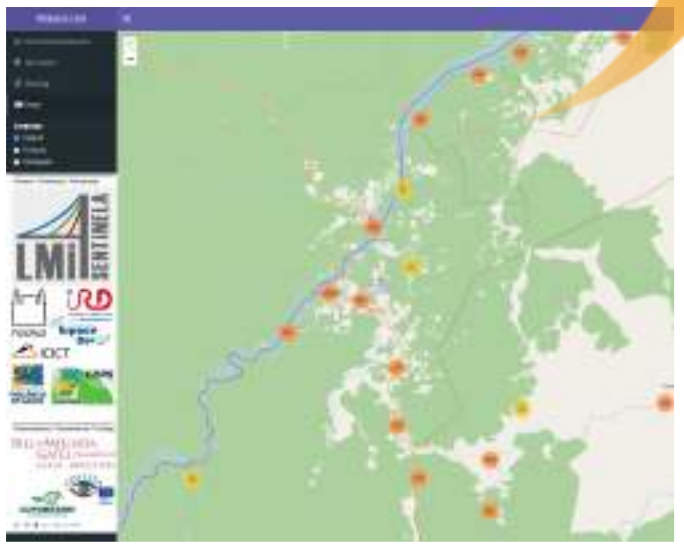
- Indicator production and aggregation, dissemination
- **Next steps**

Parasite circulation indicators

Observatório Nacional de Clima e Saúde

Outros Websites





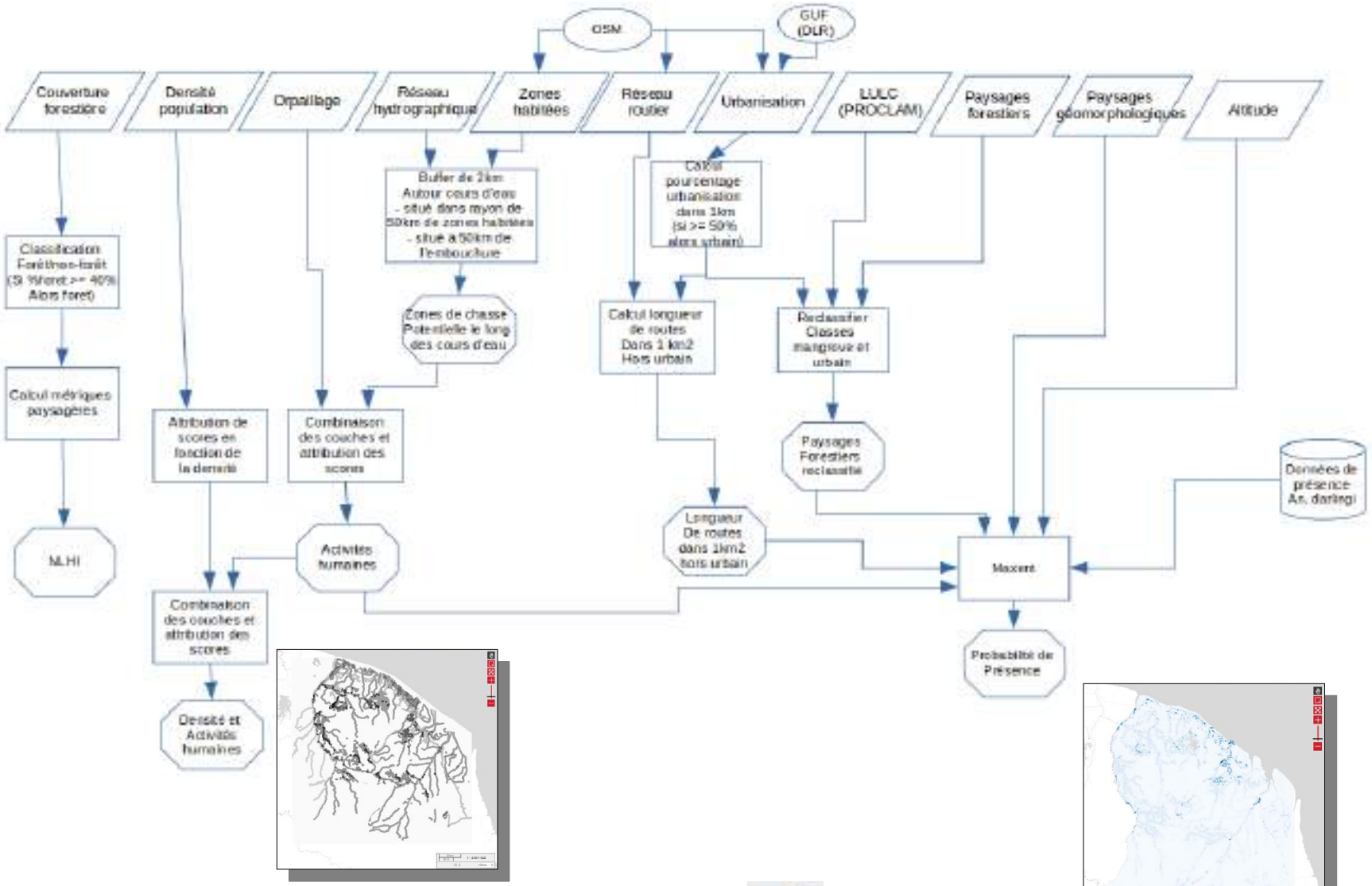
https://shiny.icict.fiocruz.br/publicirdmalaria/

Cross-border epidemiological surveillance

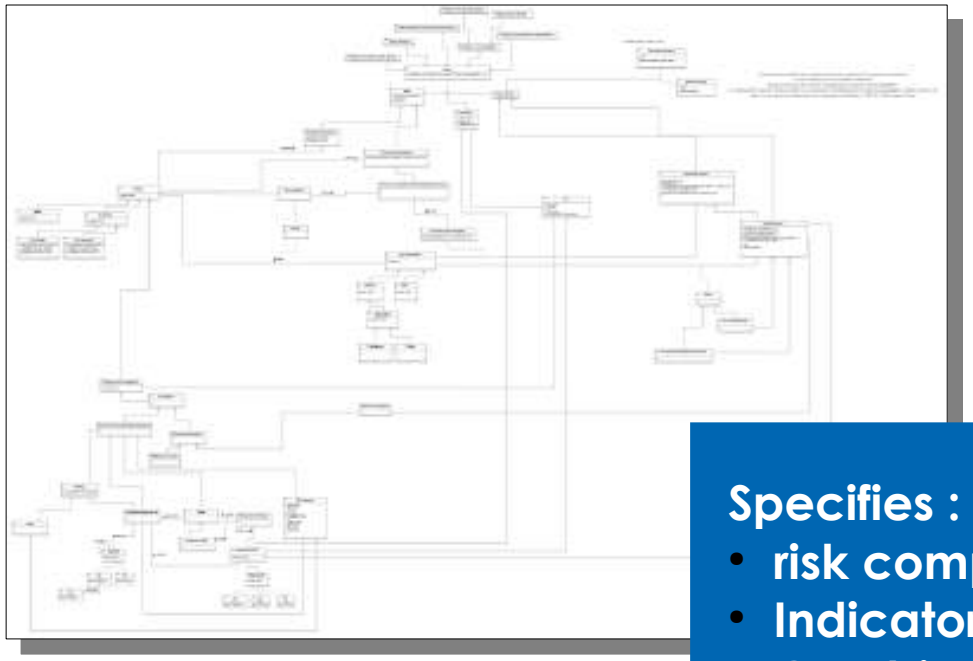
[Saldanha et al., JMIR, 2020]

Defining parasite circulation ''basins''
Toward an Exposition risk to transmission (in population)

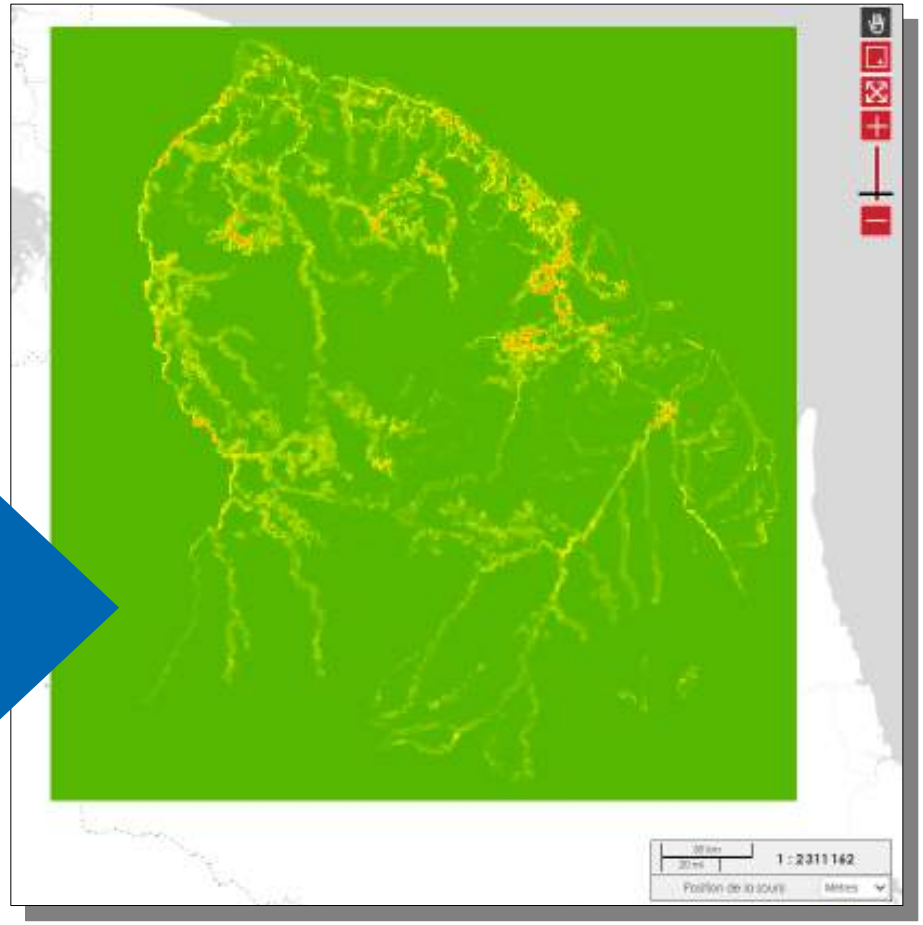
Formalisation of the indicator production chain



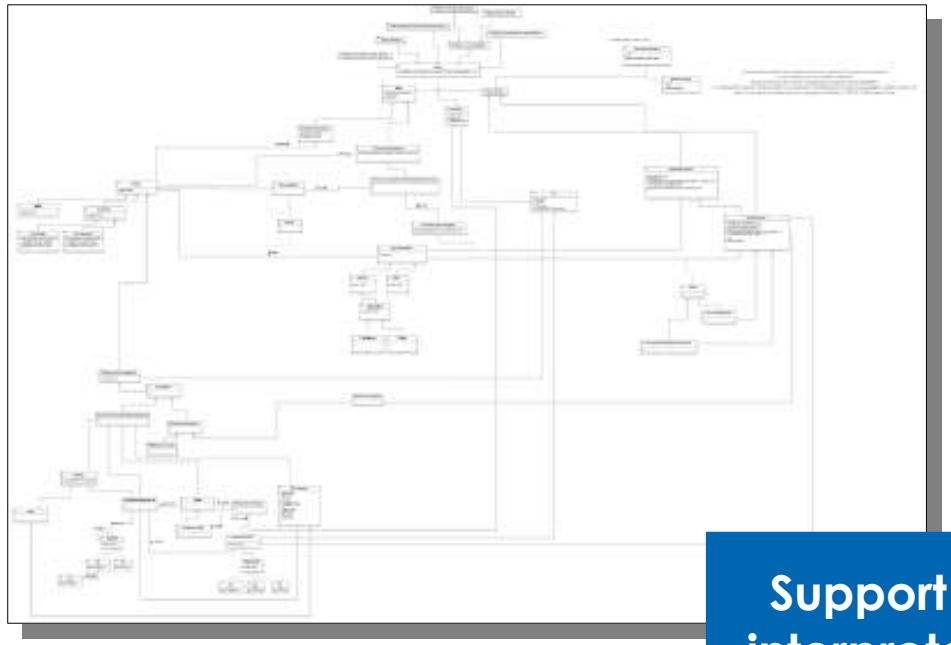
Mapping based on conceptual model



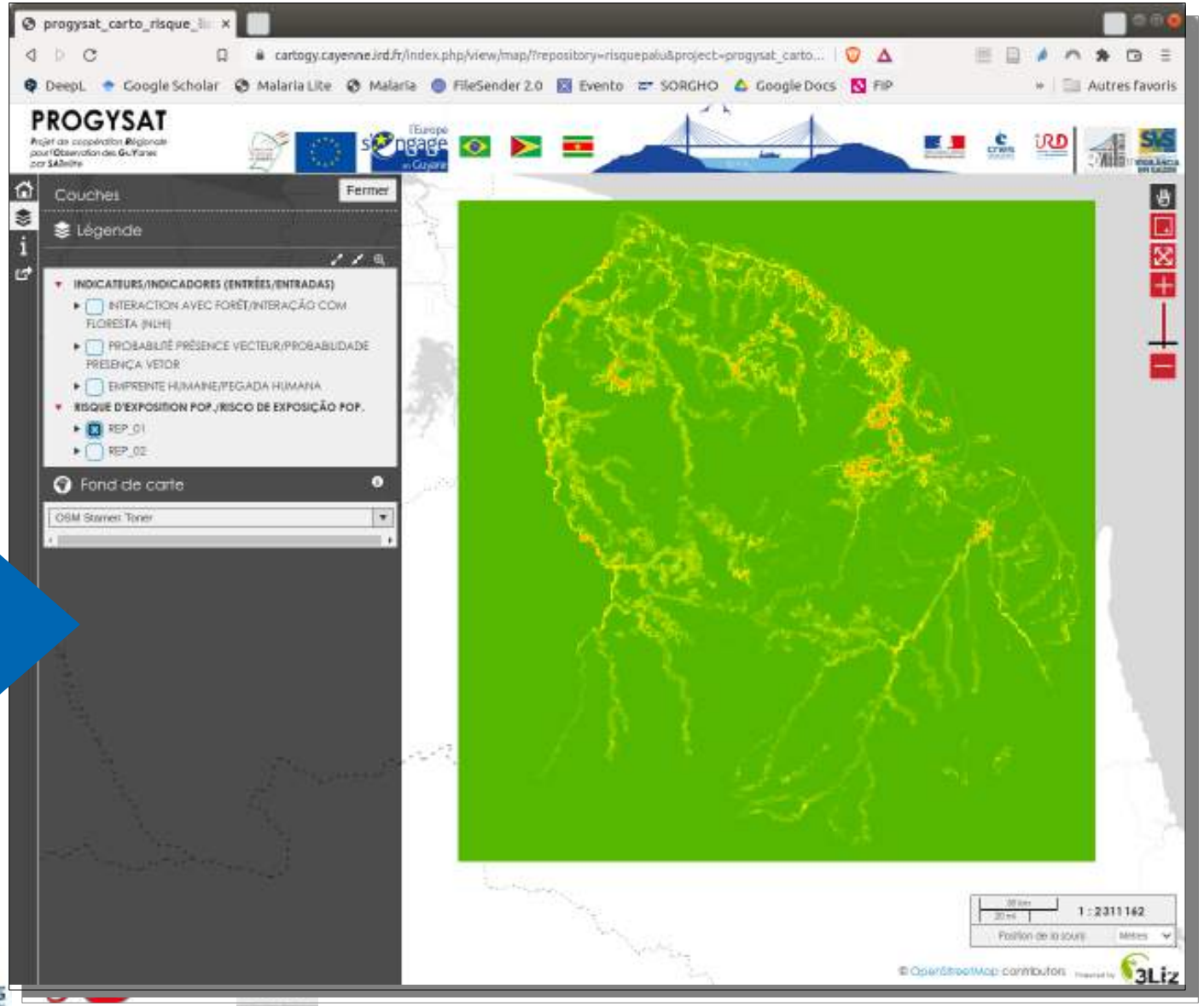
Specifies :
- risk components
- Indicators
- Combination type (+, x, +/x)
- weights



Transfer, dissemination of data and knowledge



Support the interpretation



https://cartogy.cayenne.ird.fr/index.php/view/map/?repository=risquepalu&project=progysat_carto_risque_lizmap

Special thanks to

Partners who participated to workshops

French guiana

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- Johana Restrepo (CTG/LAV, Entomology)
- Yann Lambert (CHC/CIC, Malakit project)
- Luisiane Carvalho (SPF/CIRE Guyane, malaria referrer)
- Alice Sanna (CHC/CIC, OMS/OPAS)
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- *Igor Fernando dos Anjos Barros (SVS-AP)
- *Anaytatyana Maciel (SVS-AP, VigiFronteiras-Brasil program)
- *Allan Kardec Galardo (IEPA)
- *José-Joaquín Carvajal (ILMD-Fiocruz, LMI Sentinela)
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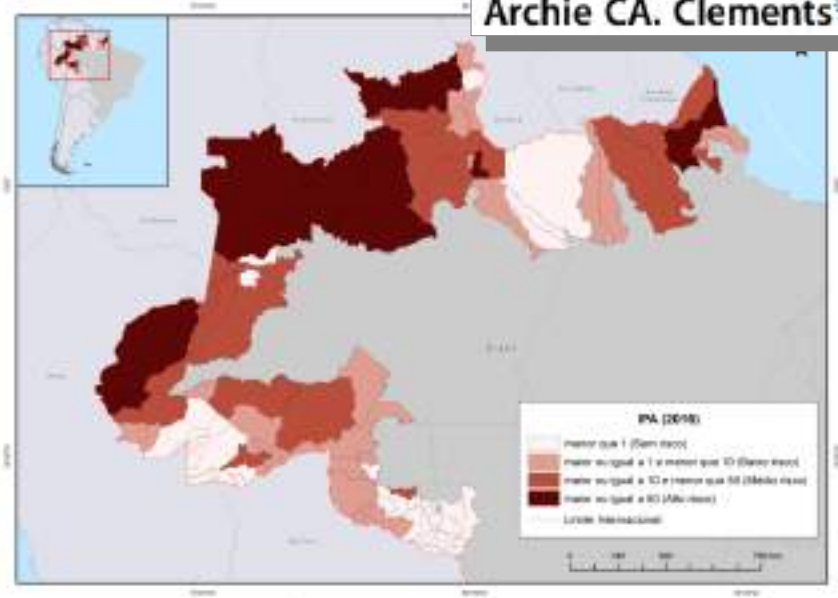
- Carolina de Abranches

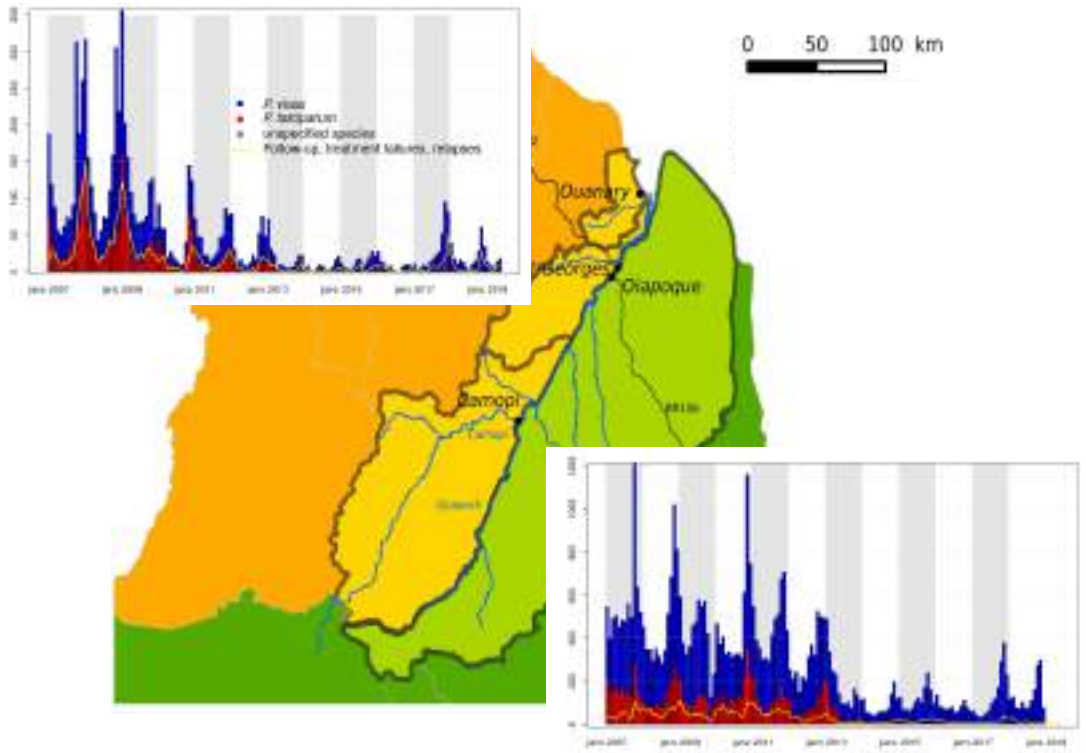
Cross-Border Malaria: A Major Obstacle for Malaria Elimination

Kinley Wangdi*,§,1, Michelle L. Gatton¶, Gerard C. Kelly*, Archie CA. Clements*

[Wangdi et al., 2015]



Mapa 5- Distribuição do Índice Parasitário Anual Médio (IPA) 2016 nos 98 municípios que conformam a área de fronteira brasileira na Amazônia.



Malaria in border municipalities

- **2003: 24,8 %** of the cases
- **2016: 61,3 %**

[Franco, 2019]

- **BR (Oiapoque): +61%** of cases between 2016 and 2017 (**2017: 1595 cases**)
- **GF (border municipalities): +263%** of cases between 2016 and 2017 (**2017: 341 cases**)

[Saldanha et al, 2020
Mosnier et al., 2020]

Definitions

Brazil elimination plane :

- **Receptividade**

  Caraterísticas ambientais que tornem possível a presença do vetor e a transmissão vetorial a partir de reservatórios humanos.

  Na prática, consideramos receptiva qualquer área com registro de identificação de vetores da malária nos últimos cinco anos.

- **Vulnerabilidade**
  - Está relacionada ao risco de importação do parasito, seja a partir da chegadade indivíduos portadores de Plasmodium, oriundos de áreas endêmicas, quecontribuem para iniciar ou reintroduzir a transmissão autóctone em áreas anteriormente sem transmissão de malária.

Model co-construction

Workshop 4

Workshop 3
Questionnaire

Workshop 2
Questionnaire

Flow chart for
risk map construction

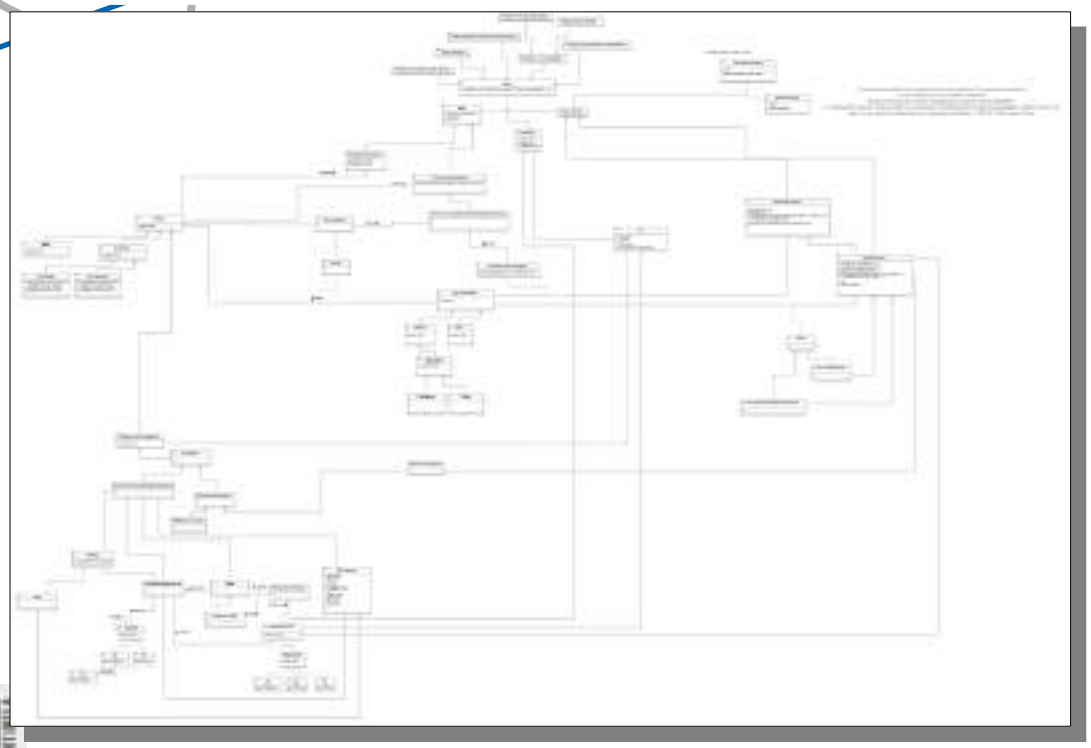
Workshop 1

Risk determinants

Expert (health actors)
explicitation

Concepts, objects
and their relationships
(UML)

Knowledge
Formalization



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[Wangdi et al., 2015]

- **Sub-nominal offer and access to care**
- Cross-border **mobility** of populations
  - Carriers of parasites
  - "Invisible" to health services (illegality)
- Significant **socio-economic inequalities**
- **Different national public policies/strategies** for disease surveillance, prevention and control
- **Lack of interoperability** of data and information systems
- …

⇒ Persistence of transmission foci
⇒ Emergence of resistances (vectors and parasites)
⇒ Lack of unified and shared representation of the situation
⇒ Lack of joint and concerted actions