Climate Research for Development (CR4D)

End of Grant Workshop

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Impact of climate change on the transmission risk of malaria in southern Côte d'Ivoire.

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Introduction

- In Côte d'Ivoire, malaria is the disease that has the greatest impact on health
- The geographical distribution of the disease in the country is not homogeneous (Raso et al., 2012)

- Studies in different parts of the world show that malaria transmission is influenced by variations in weather conditions that affect the life cycle of malaria vectors and the transmission cycle of the malaria parasite (Dekel et al., 2016; Bhatt et al., 2015; Caminade et al., 2014; Lowe et al., 2013)

- However, the impact of climatic parameters on malaria varies by region and ecological systems (Craig et al., 1999)

Introduction

Project main objective: Analyze the climatic and environmental parameters associated with malaria transmission in Tiassalé, a city located in the south of Côte d'Ivoire.

Specific objectives:

1. Assess the impact of climatic seasonality on the seasonality of malaria transmission
2. Evaluate, over the last 30 years, the effects of rainfall and temperature on malaria transmission
3. Assess the effect of land use on malaria in Tiassalé
4. Develop a malaria early warning system in collaboration with the national malaria control program

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Methodology

Picture 1: Training session for investigators

Picture 2. Parasitological survey (thick smear and blood smear)

Picture 3. Malaria clinical data collection from consultation registers

Picture 4. Household questionnaire survey

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Methodology

Picture 5. Larval sites location and description

Picture 6. Location and description of dumping of garbage

Picture 7. Stagnant water point location and description

METEOROLOGICAL DATA COLLECTION

- Temperature, rainfall, relative humidity

ADULT MOSQUITO CAPTURE

- Insecticide-based indoor capture sprayed in a bedroom (CID)
- Capture with Light Traps inside the house from 7 pm to 6 am (CDC LT).
- Capture with human baits from 6 pm to 6 am inside and outside the houses (CSAH)

Some Results

Malaria prevalence in Tiassalé (August - Sept 2020)

Malaria	Frequency	Percent	Cum. Percent
No	204	80,31%	80,31%
Yes	50	19,69%	100,00%
Total	254	100,00%	100,00%

Exact 95% Conf Limits		
Non	74,89%	85,02%
Oui	14,98%	25,11%

Around 20% people with malaria stays home instead of going to the hospital.

Fever (T>=37.5°c), headaches and fatigue are the main signs observed in people suffering from malaria in the city of Tiassalé. The presence of these signs can mean having malaria.

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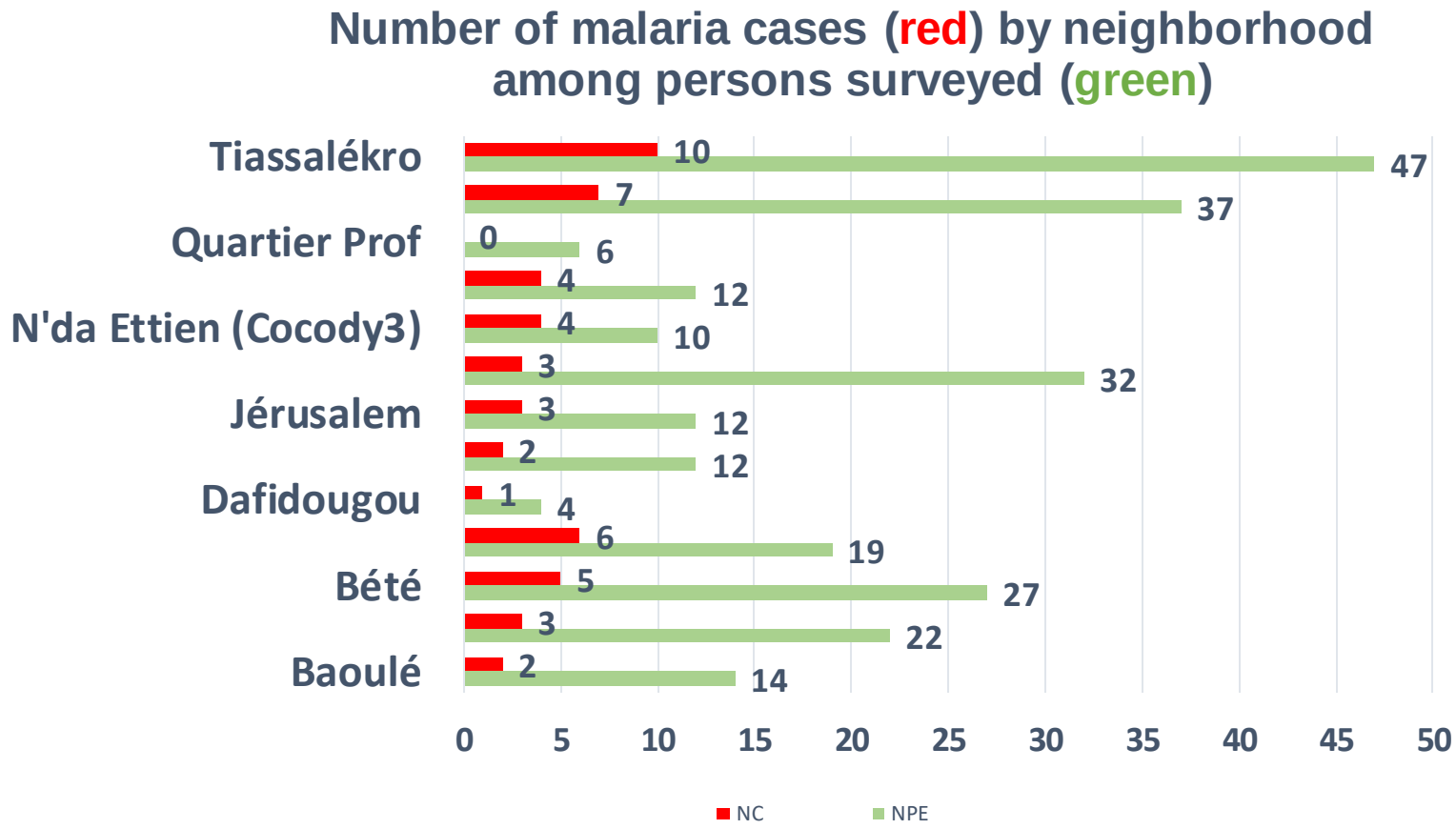
Some Results

Malaria prevalence in Tiassalé (August - Sept 2020)

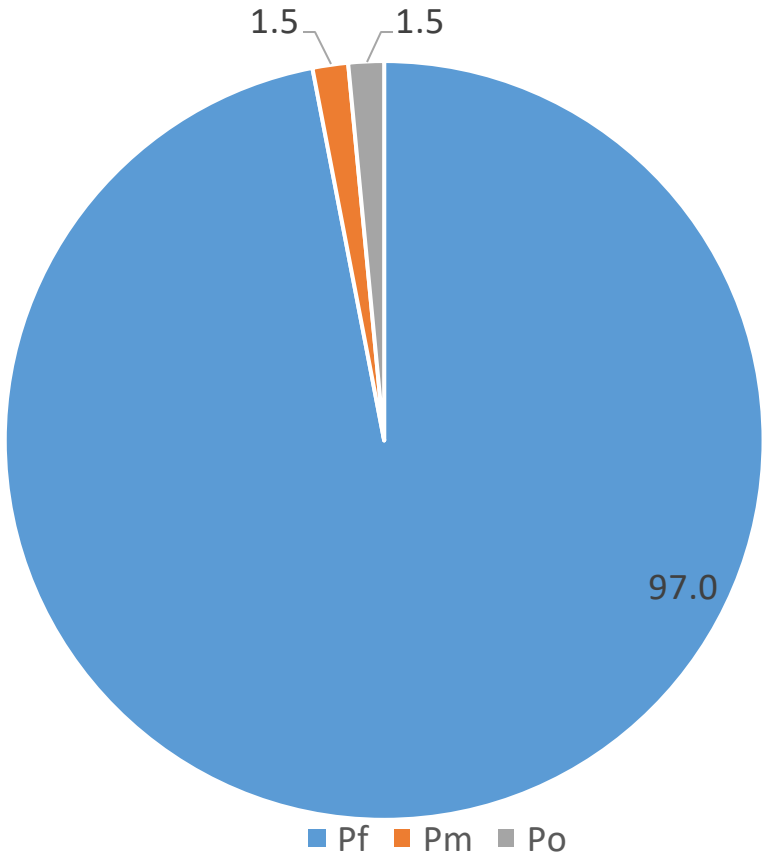
Apart from the neighborhood "Quartier Prof", several cases of malaria are observed in all the city of Tiassalé



N'da Ettien (40%); PTT (33,3%); Corridor (31,58%); Dafidougou (25%); Jerusalem (25%); Tiassalekro (21,3%); Résidentiel (18,9%); Bété (18,52%); François Kadjo (16,67%); Baoulé (14,29%); Belle ville (13,64%); Mosquée (9,38%); Quartier Prof (0%)

Some Results

Malaria prevalence in Tiassalé (August - Sept 2020)



Prevalence of plasmodium species in Tiassalé (August-September 2020)

Our study confirms that *Plasmodium falciparum* (Pf) is responsible of the majority of malaria cases in the city of Tiassalé.

Some Results

Climatic and environmental factors and malaria transmission in Tiassalé in 2020

CID	Total caught	Mean/ day
Corridor	68	4,5
Quartier Bete	0	0
Tiassalekro	12	0,8
Quartier Residentiel	7	0,5
Quartier Belle Ville	2	0,1

CSAH	Total capturé	Density/ day
Tiassalekro	1428	79,3
Francois Kadio	15	0,83

CDC LT	Total caught	Number/ day
Tiassalekro	141	14,1
Residentiel	91	9,1
Francois Kadio	0	0

CSAH	Infection rate	Entomological Inoculation Rate	Entomological Inoculation Rate
Tiassalekro	0	0	0
Francois Kadio	0,76	0,636 pi/H/n	234 pi/H/an

pi/H/n : number of infected bites per person per night

pi/H/an : number of infected bites per person per year

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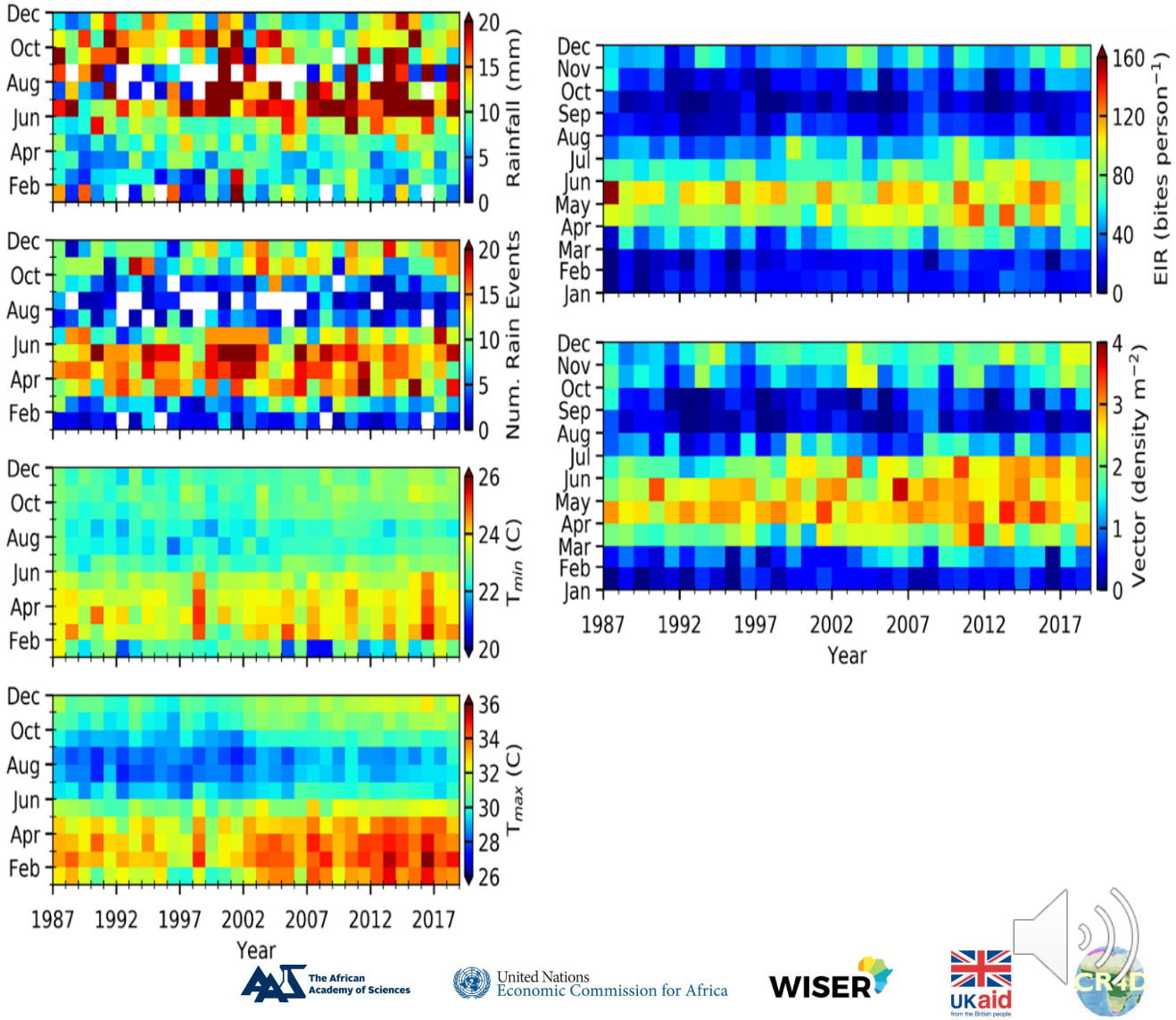
Some Results

Climatic factors and malaria transmission in Tiassalé (1987 - 1999)

Over the past thirty-two years (1987 to 2019), we observe:

An increase in daily temperatures and the number of rainfall events from February to June each year. From July to December, we observe much more spaced rains.

An increase in the number of infesting bites per person and per unit of time (day, month, year,...) as well as the number of mosquitoes per surface unit from March to July of each year.



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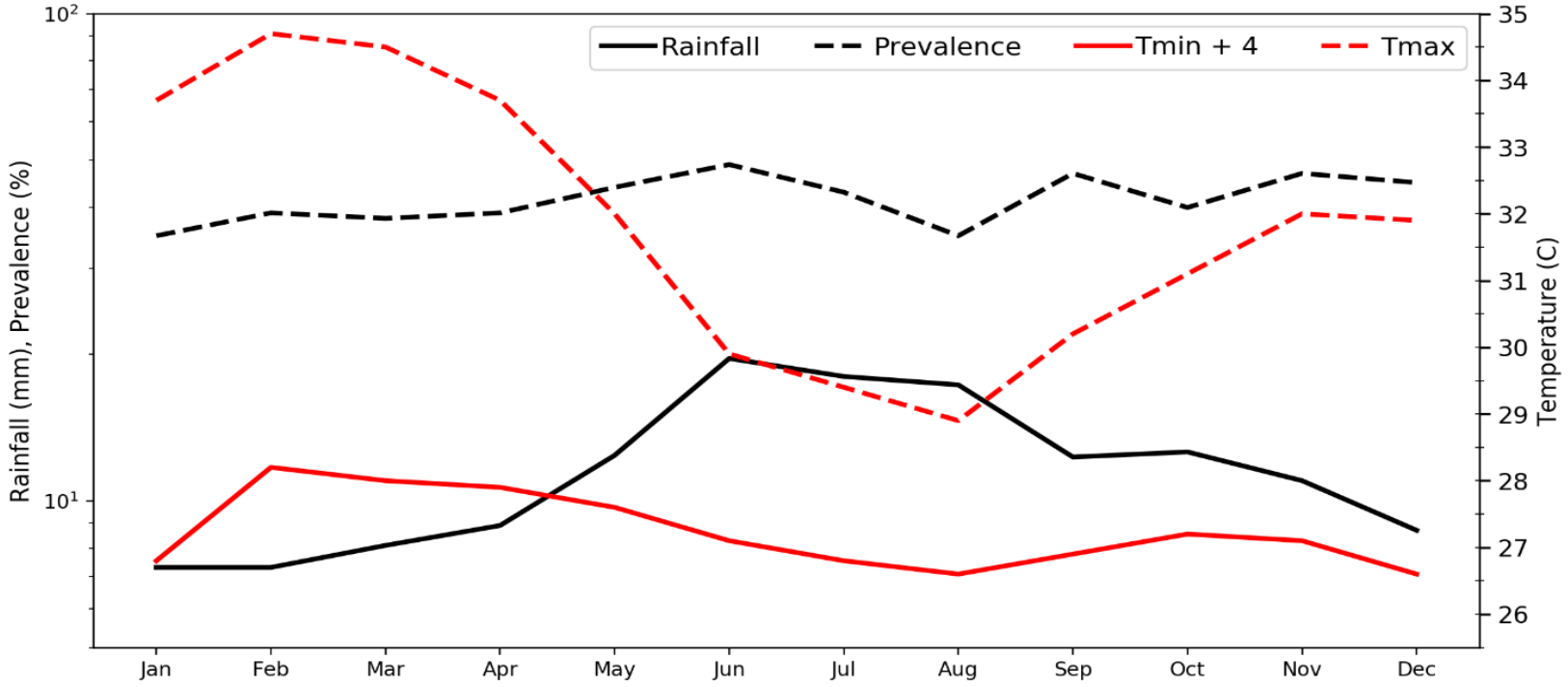
Some Results

Climatic factors and malaria transmission in Tiassalé (1987 - 1999)

Over the past ten years (2010 to 2019), we have observed

A high prevalence of malaria in Tiassalé from March/April to July of each year and a slight overall decline marked by a sawtooth pattern from August to December



Some Results

Climatic factors and malaria transmission in Tiassalé (1987 - 1999)

The prediction model used (VECTRI) shows a progressive increase in malaria transmission in Tiassalé for the coming decades (2030, 2050 and 2080).

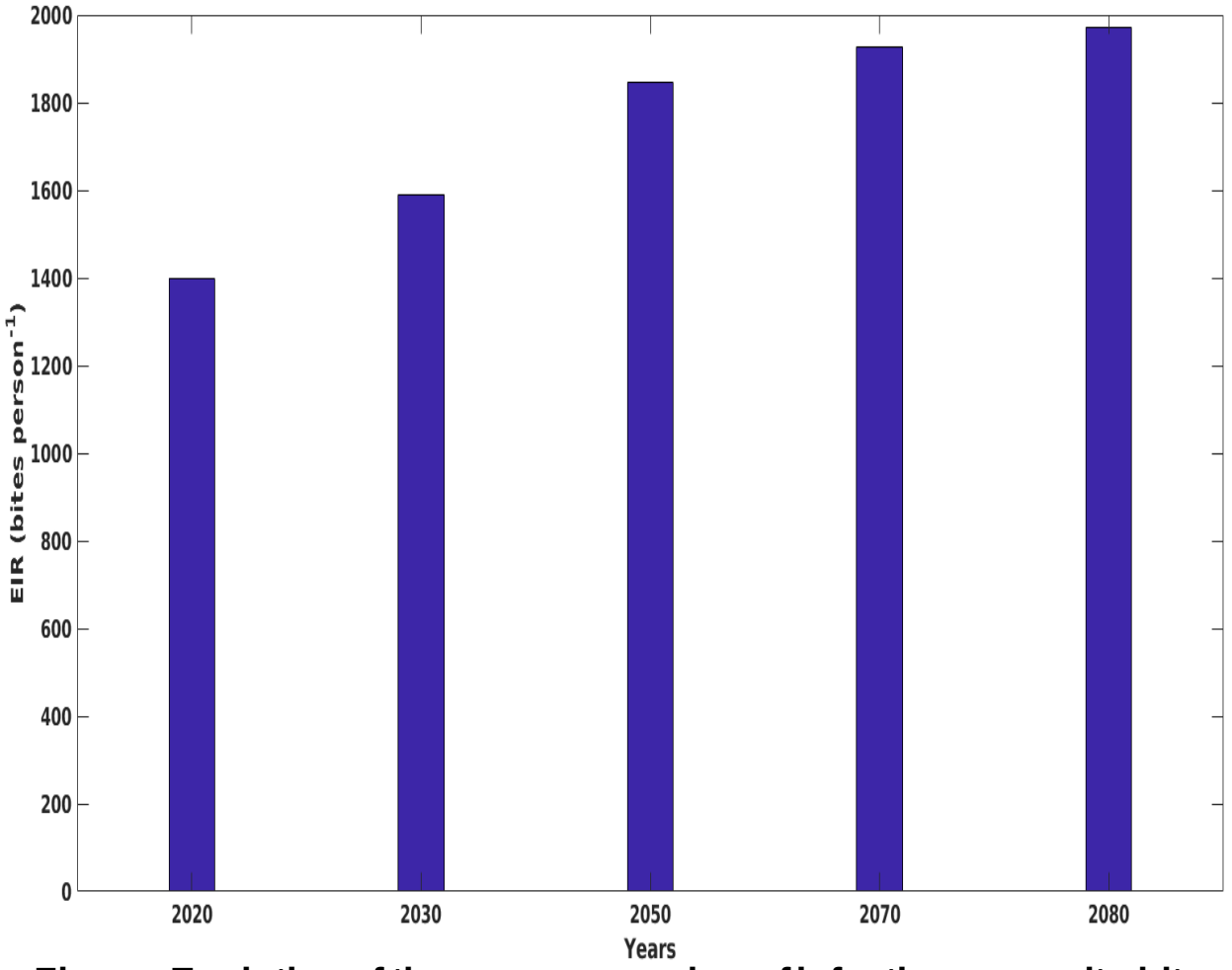
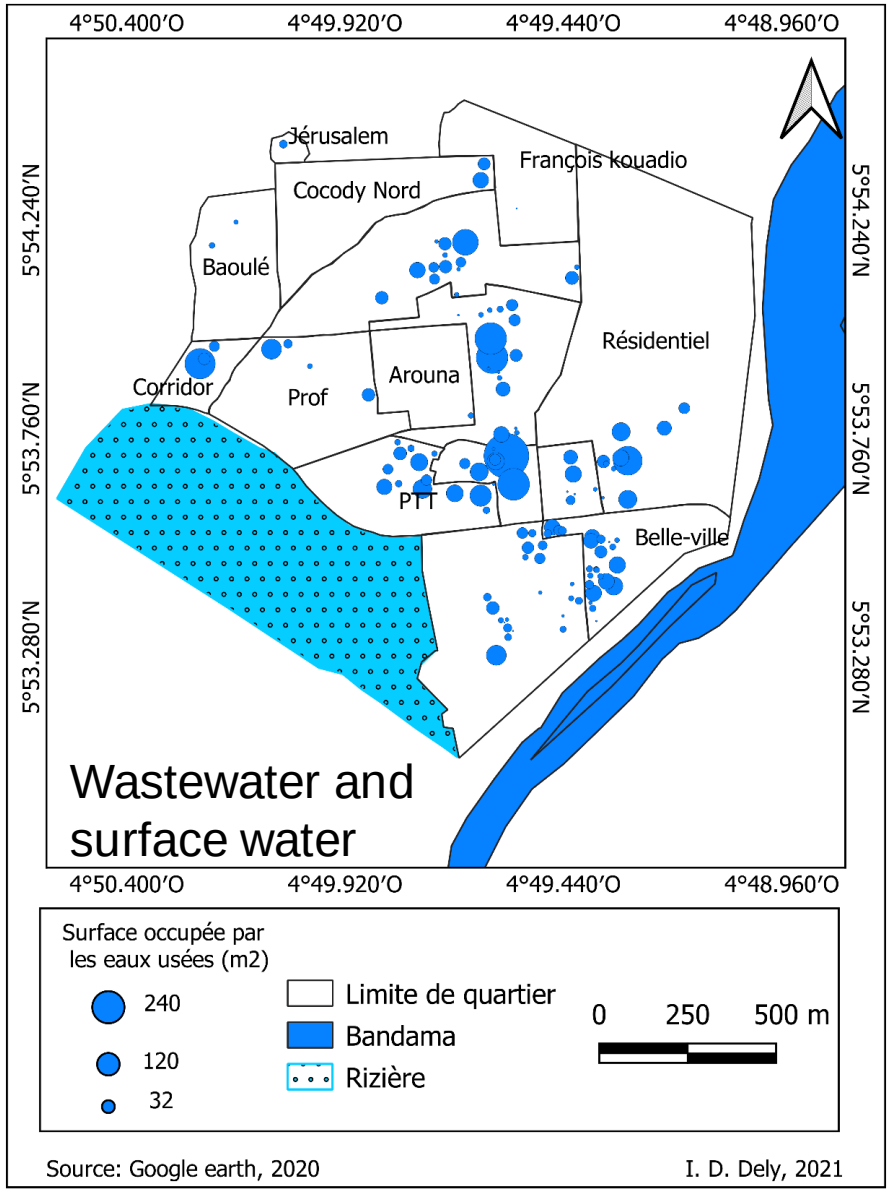
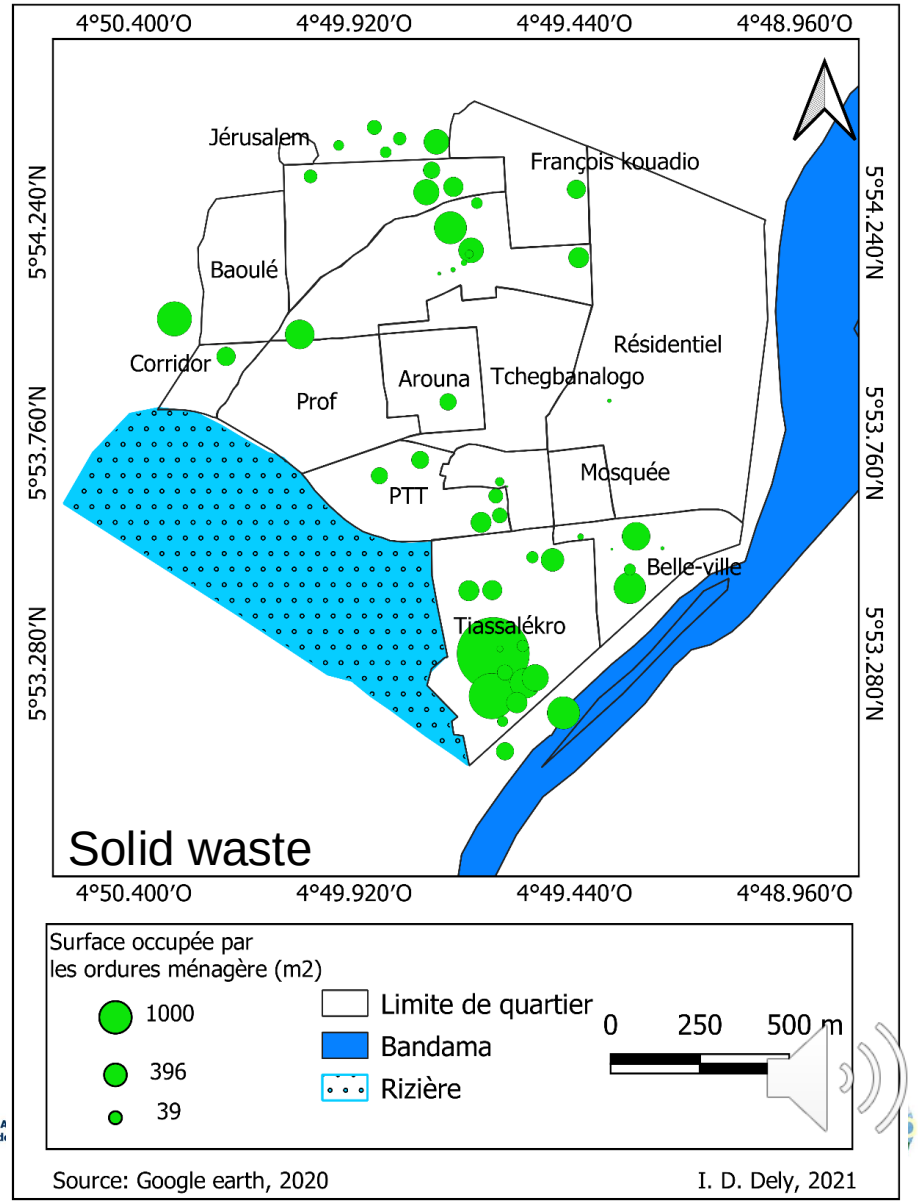


Figure: Evolution of the average number of infecting mosquito bites per person per unit of time until 2080

Some Results

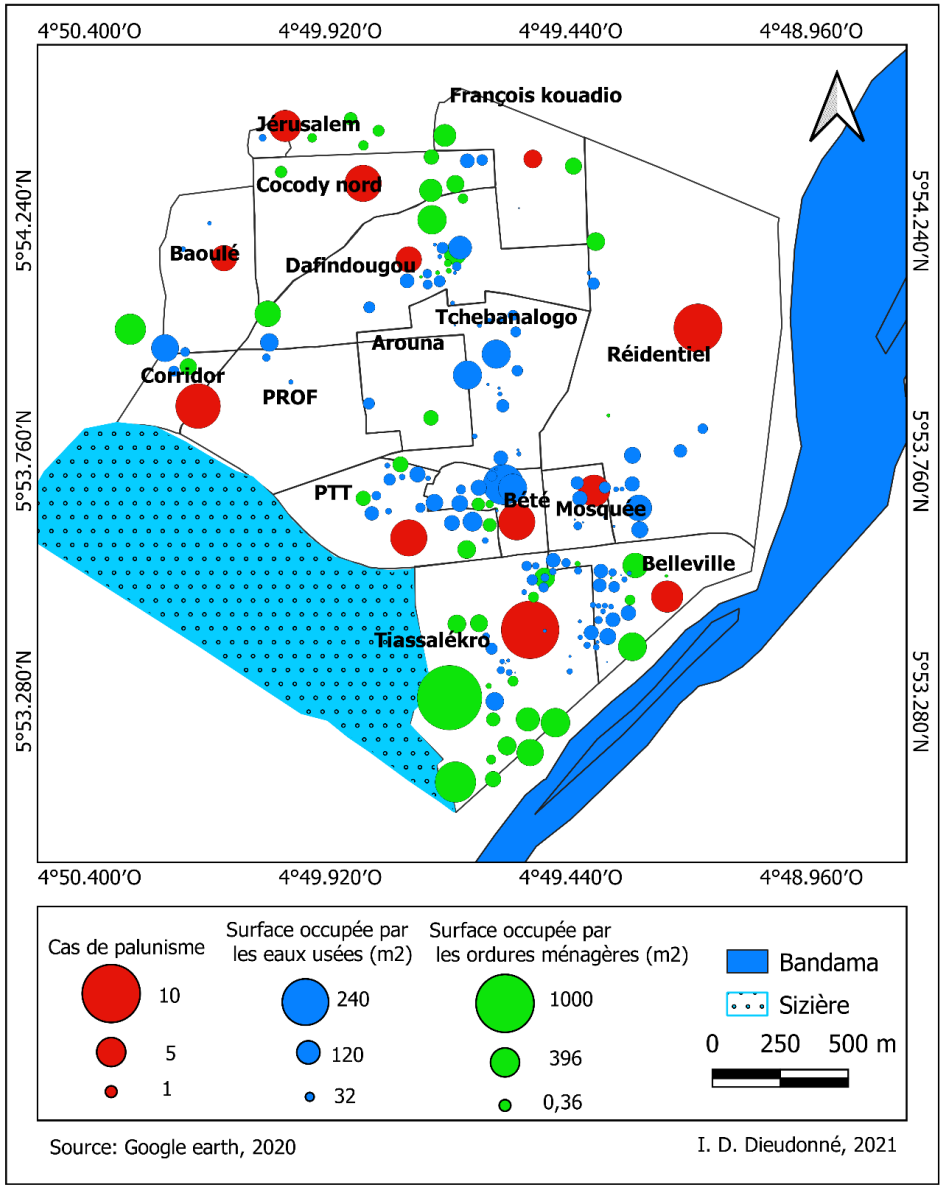
Socio-environmental factors of malaria transmission in Tiassalé (August - Sept 2020)





Some Results

Socio-environmental factors of malaria transmission in Tiassalé (August - Sept 2020)



Wastewater, Solid Waste and Malaria Cases

Some Results

Knowledge, Attitudes and Practices of the population in relation to malaria in Tiassalé

Lack of knowledge on the causes of malaria by a large proportion of the population

- For a quite important proportion of the population surveyed in Tiassalé (37.14%), the causes of malaria are still unknown.

- This proportion is highest among merchants, compared to other socio-professional groups

Malaria Causes	Farmer	Merchant	Employee	unemployed	Total
Good answer	11 73,33%	16 48,50	9 81,82%	8 72,73%	44 62,86
Bad answer	4 26,67%	14 51,87%	2 18,18%	3 27,27%	26 37,14
Total	15 100%	27 100%	11 100%	11 100%	70 100%

Some Results

Knowledge, Attitudes and Practices of the population in relation to malaria in Tiassalé

Lack of awareness on mosquito-borne diseases among the population

- About 1/3 of the people surveyed (34.29%) do not know enough about mosquito-borne diseases.

Knowledge on mosquito-borne diseases	Male	Female	Total
Good answer	19 65,52%	27 65,85%	46 65,71%
Bad answer	10 34,48%	14 34,15%	24 34,29%
Total	29 100%	41 100%	70 100%

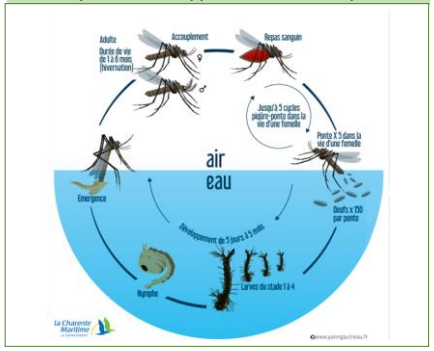
POSTER EDUCATIF SUR LE PALUDISME : Cycle de développement des vecteurs (Moustiques) et parasites (Plasmodium) responsables du paludisme

Le paludisme est une maladie due à un microbe ou parasite appelé *Plasmodium*. Ce parasite est transmis à l'Homme par la piqûre d'un moustique femelle (*Anopheles*). Les enfants de moins de 5 ans et les femmes enceintes sont les plus fragiles face à la maladie.

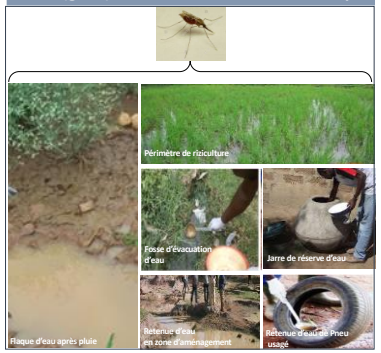
Le paludisme est un problème majeur de santé publique, particulièrement en Afrique subsaharienne. Le nombre de malades et de décès dus à cette maladie est toujours élevé. En 2019 il y a eu 229 millions de cas de maladie dans le monde et 409000 décès (dont plus de 94% en Afrique) malgré les efforts de lutte au niveau local, national et international.

Les méthodes de lutte incluent principalement la lutte contre les moustiques vecteurs, l'identification rapide et le traitement correcte des cas, l'assainissement de l'environnement et du cadre de vie. Ces méthodes doivent être adaptées selon les endroits où sévit la maladie. Elles nécessitent une bonne connaissance du cyle de vie des vecteurs et parasites responsables de la transmission.

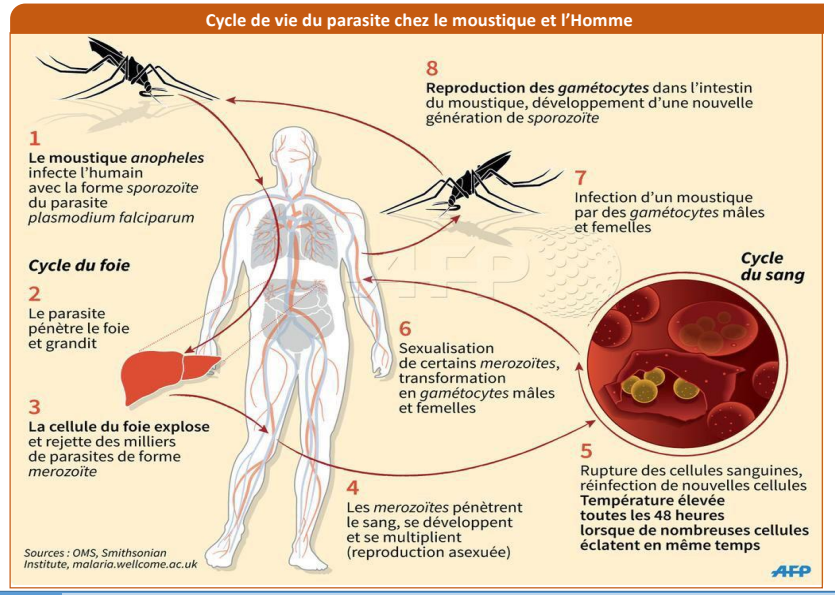
Cycle de développement du moustique



Lieux (gîtes) favorables à la vie du moustique



Cycle de vie du parasite chez le moustique et l'Homme



Some Results

Results shared with stakeholders and capacity building activities

Assessing climate variability on the risk of transmission of malaria in an endemic area of Tiassalé (southern Côte d'Ivoire)

Abstract

Malaria is the disease that has the most significant health burden in Côte d'Ivoire and is a major public health challenge. Although malaria is climate driven, there are limited studies linking the relationship between climate variables and malaria transmission in southern part which represents the more endemic of malaria of the country. We used the VECTRI (vector-borne disease community model of the International Centre for Theoretical Physics, Trieste) model to investigate the spatio-temporal variability in malaria transmission patterns over Tiassalé (southern of Côte d'Ivoire). The model is driven using daily temperature (Tmin and Tmax) and rainfall datasets obtained from the African Rainfall Climatology Version 2 (ARC2) and ERA5 Reanalysis between 1987 and 2019. In addition, the potential of the VECTRI model to simulate seasonal pattern of local scale malaria risk is assessed. The model results reveal that the simulated malaria transmission follows temperatures (Tmin and Tmax) and in the number of rainfall events peaks. Furthermore, malaria transmission is high in all months with a peak in June which coincides with the peak of rainfall and the decrease in Tmin and Tmax. The results further reveal that the increase of the annually Entomological Inoculation Rate (EIR) and vector density, simulated with VECTRI, correspond approximately to the same period of increased rainfall and Tmax. High monthy EIR, vector density and temperature and rain event during March to July tends to agree with malaria prevalence peak reported malaria cases from ISG hospital located in Tiassalé and obtained from field surveys. Furthermore, despite being a regional model, VECTRI demonstrates useful skill in reproducing monthly variations in reported malaria cases from Tiassalé and may possesses the potential to provide useful information for malaria control.

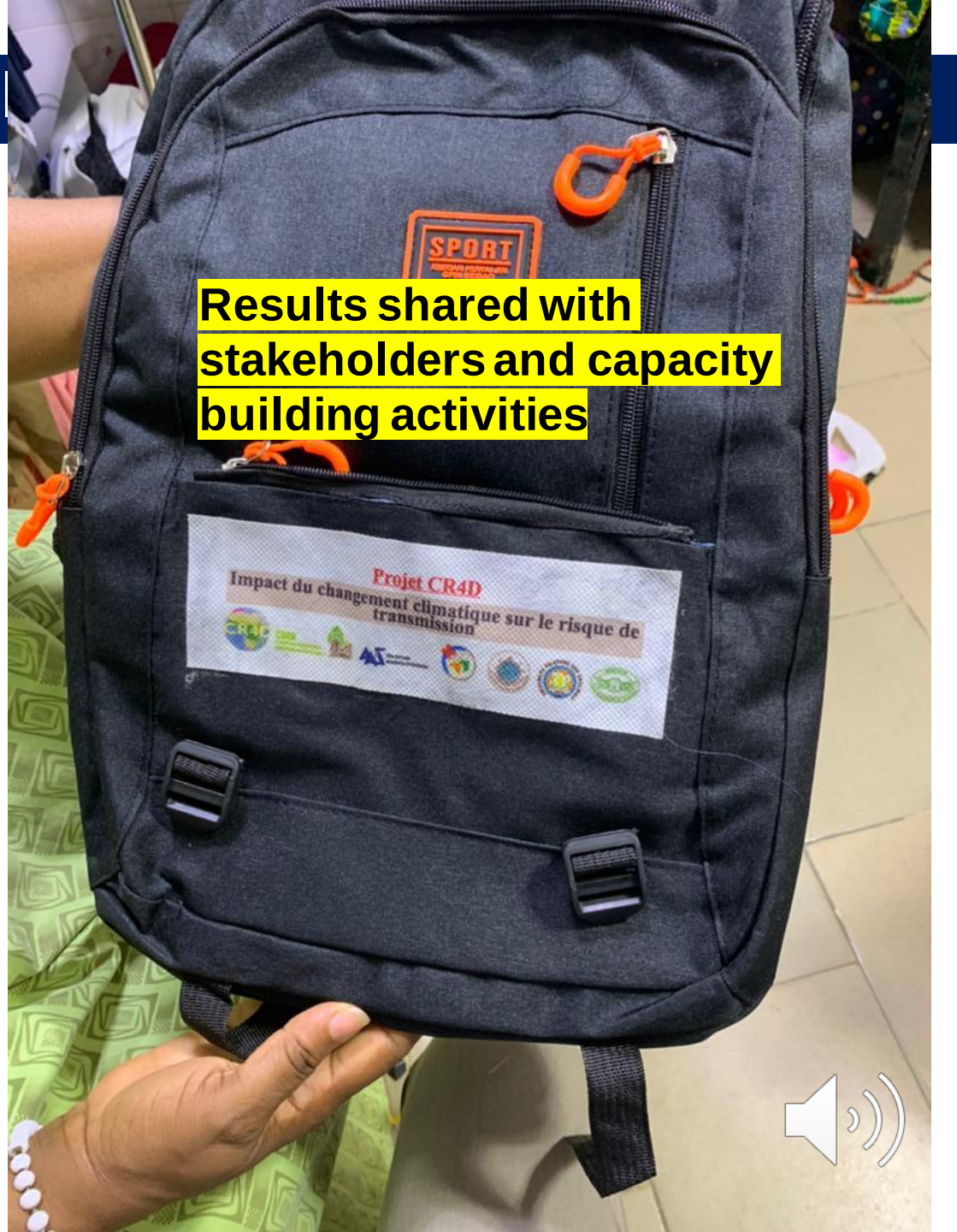
Keywords: VECTRI, malaria, EIR, vector density, Tiassalé

Introduction

Malaria is transmitted throughout the year in Côte d'Ivoire, and poses a significant public health challenge. It is the first reason for consultation, with more than 40% and 62% of hospitalizations for the less than 5 years old (Thesis Fakih, 2014; Zogo, 2019). As in most endemic countries, children under five years of age and pregnant women are the most vulnerable and are therefore more likely to develop severe malaria (NMCP, 2018). Recently in Côte d'Ivoire, the number of malaria cases has been estimated at 3,373,436 and the number of associated deaths at 9,579 in 2017 (WHO, 2018). For example, in unimmunized pregnant women, the risk of increased and the mortality rate from severe malaria in pregnancy is increased 50% (WHO, 2013). Thus, pregnancy generates a decrease in immune defenses and a greater likelihood of contracting severe anemia (WHO, 2010). Most importantly, actual malaria cases are likely to be higher than

Some Results

Results shared with stakeholders and capacity building activities



Results shared with stakeholders and capacity building activities

Conclusion

- High proportion of home malaria cases in Tiassalé with a globally heterogeneous spatial distribution
- Plasmodium falciparum is the predominant specie among those responsible for malaria
- Fever, headaches and fatigue are the main signs associated with malaria
- Malaria transmission in Tiassalé is associated with rainy events and temperatures
- If nothing is done, projections show an increase in malaria transmission in the coming decades
- The distribution of socio-environmental factors (surface or wastewater and uncontrolled garbage dumping) is globally superimposed on those of the distribution of malaria cases
- A large proportion of the population is still unaware of the causes of malaria and the diseases caused by mosquitoes despite numerous awareness campaigns
- Little is known about the link between climate variability and malaria
- Results are useful for setting up a malaria EWS in the southern part of Côte d'Ivoire

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