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Towards the elimination of malaria in the Union of Comoros: geographical insight on control actions and maintenance factors

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Introduction

Background

Malaria has long been endemic in the Union of Comoros. Since 2007, the Comorian government has been conducting a national strategy for eradicating malaria by Artemisinin-based combination therapies (ACTs) administration, mass drug administration with dihydroartemisinin-piperazine plus primaquine and large-scale distribution of long-lasting insecticidal nets (LLINs). Between 2010 and 2014, the number of malaria cases has radically fallen by more than 90%. This study aims at describing the spatial patterns of the epidemiology of malaria and at identifying risk factors through a geographical approach.

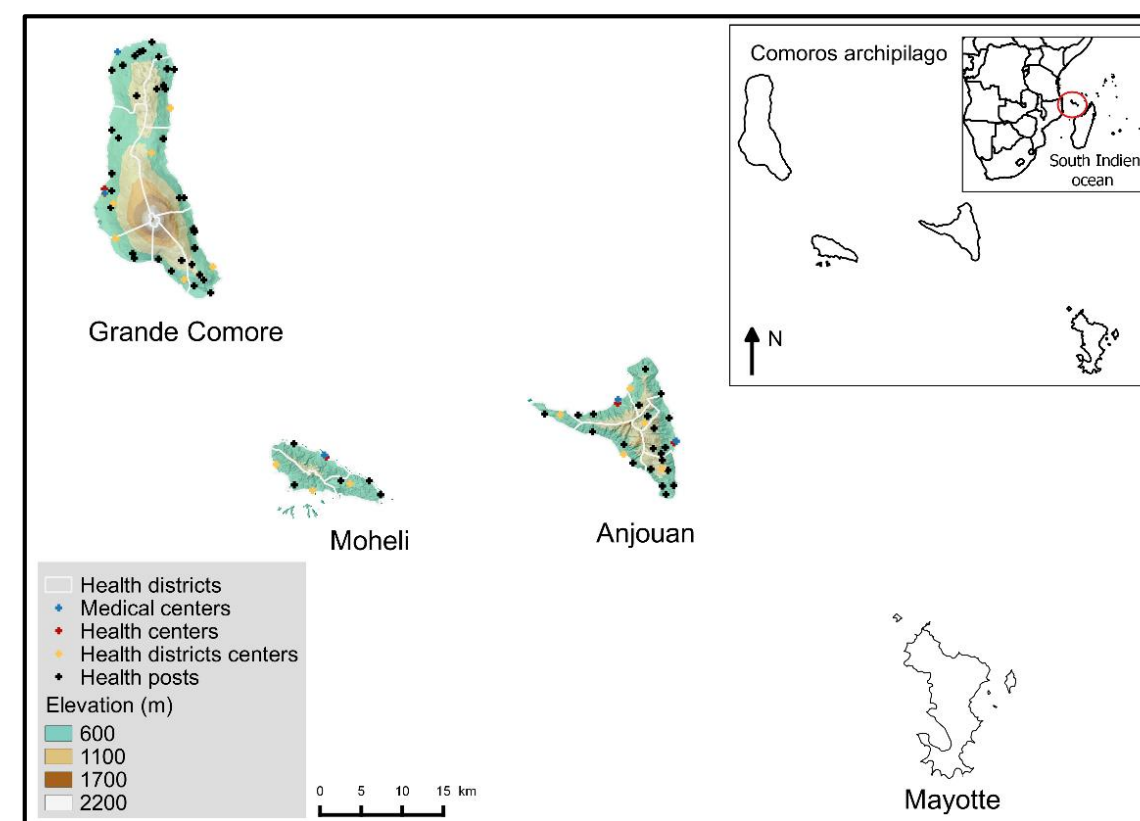
Therefore, the purpose of this study is to:

- characterize the spatial and temporal dynamics of malaria,
- describe its ecological and social patterns,
- assess the impact of control actions,
- statistically model its distribution.

Material and methods

Study area

Located at the northern of the Mozambique Channel between the east coast of Africa and Madagascar, Comoros archipelago is composed of four islands: Grande Comore (1,147 km²), Anjouan (424 km²), Moheli (360 km²) and Mayotte (376 km²).



Epidemiological information

Monthly cases, as reported by the "Programme National de lutte contre le paludisme" (PNLP) from 2010 to 2014, were geo-referenced in the three islands at different scales: by sanitary district and by health center. The incidence of malaria by district was calculated using population data from the National Census. We calculated the clinical prevalence of malaria by health center using the number of clinical patient.

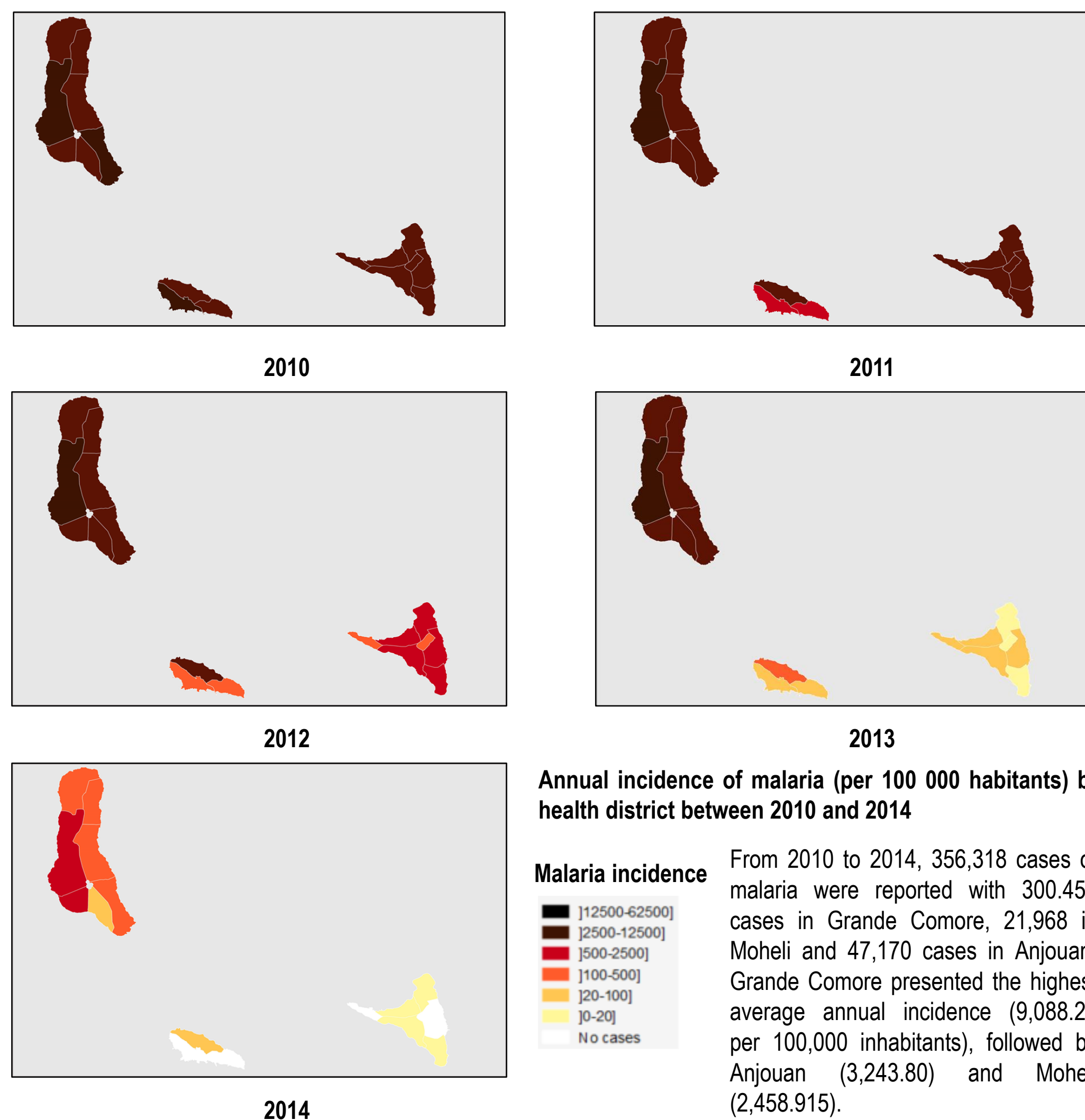
Control actions information

Data of Artemisinin-based combination therapies (ACTs), mass drug administration with dihydroartemisinin-piperazine plus primaquine and distribution of long-lasting insecticidal nets (LLINs) were used to determine the relation between control action and malaria cases with Linear regression model.

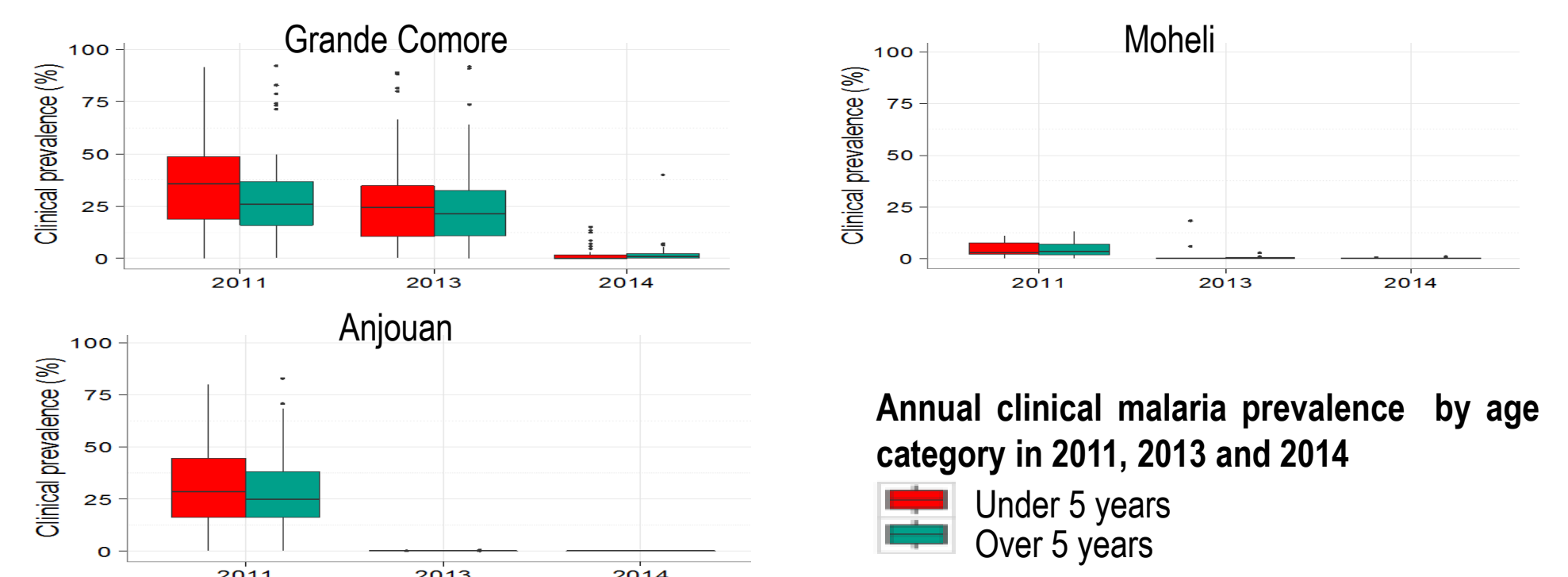
Spatial database

We completed the spatial database with data on environmental and social factors including meteorology, physical geography, population characteristics.

Results

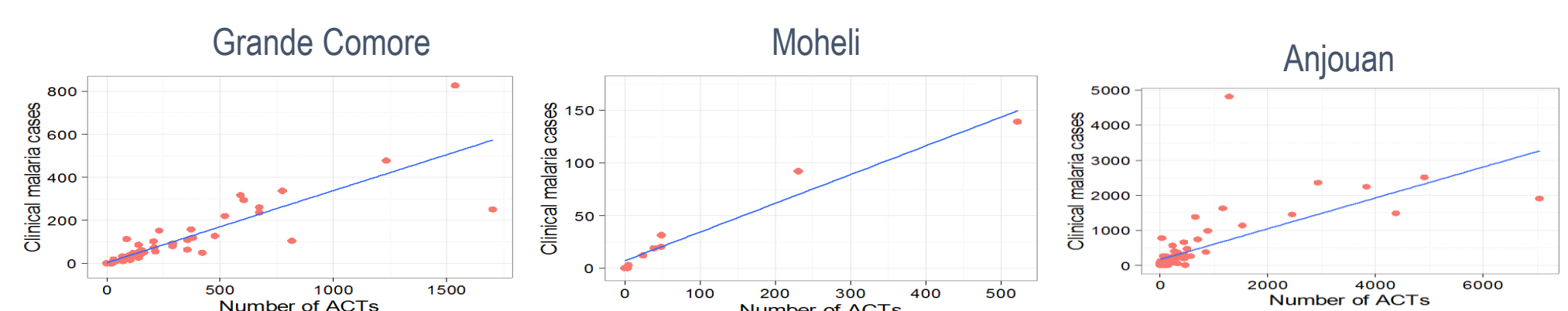


Evolution of malaria prevalence reported in health centers



In three years, 37,808 cases of malaria were reported in 181 health centers with 85.01% of cases in Grande Comore, 0.84% in Moheli and 14.15% in Anjouan. Grande Comore presented the highest average annual clinical malaria prevalence (91.83% of cases), followed by Anjouan (11.22%) and Moheli (1.97%). Population over 5 years presented the highest clinical malaria prevalence with 63.90% against 36.10% of children under 5 years. The highest clinical malaria prevalence of children under 5 years were reported in Moheli (45.56%). From 2011 to 2014 clinical malaria prevalence has decreased severely with reduction rate of -94.35% in the Union of Comoros.

Malaria treatment



In the three years 59,495 malaria patients were treated by Artemisinin-based combination therapies (ACTs). Using linear regression model, we observed high relation between ACTs administration and clinical malaria cases in Moheli (RR= 0,95, p value=6.16e-06) and Anjouan (RR= 0,72, p value= 2.43e-15)

Malaria control actions

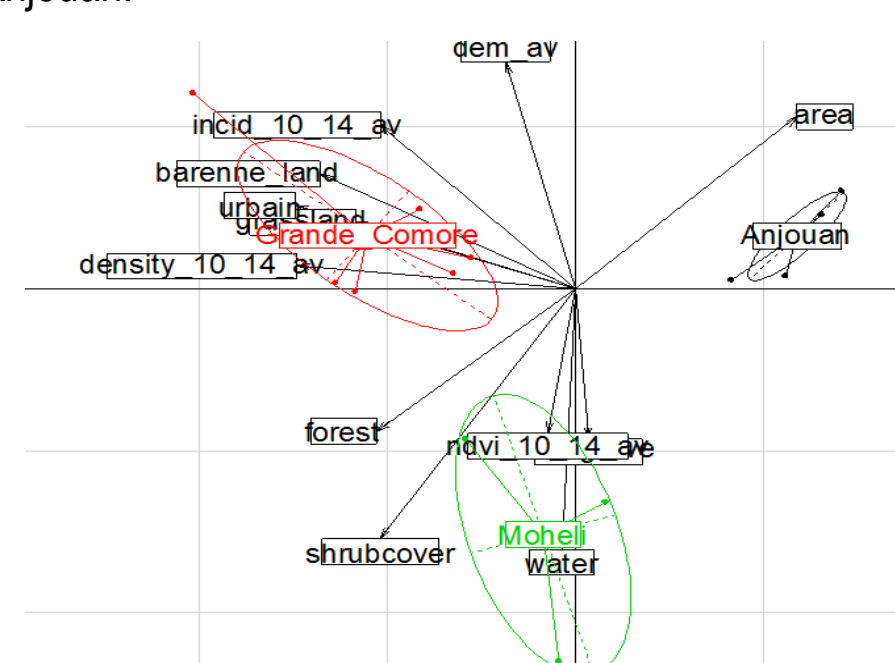
| Name island | Control actions | DF | RR | AIC | t value | Pr(> t) | Std. Error |
|---------------|---------------------------|----|------|--------|---------|----------|-----------------|
| Grande Comore | LLINs | 1 | 0.93 | 90.22 | 8.63 | 0.0003 | [0.0028-0.0249] |
| | Masse drug administration | 1 | 0.93 | 90.22 | 8.59 | 0.0003 | [0.0015-0.0135] |
| Moheli | LLINs | 1 | 0.99 | 11.30 | 53.84 | 0.0118 | [0.0001-0.0006] |
| | LLINs | 1 | 0.04 | -2.99 | 0.50 | 0.6370 | [0.0003-0.0001] |
| Anjouan | Masse drug administration | 1 | 0.12 | -2.99 | 0.85 | 0.4300 | [0.0003-0.0002] |
| | LLINs | 1 | 0.72 | 204.84 | 6.23 | 0.0001 | [0.0033-0.0209] |
| Comoros | Masse drug administration | 1 | 0.88 | 171.38 | 9.82 | 0.0000 | [0.0013-0.0135] |

Linear regression model of LLINs and masse drug administration with malaria cases by health districts

We observed a high relation between long-lasting insecticidal nets (LLINs) distribution and the malaria cases in Grande Comore (RR= 0,93, p value= 0,00034) and Moheli (RR=0,99, p value=0,011). Masse drug administration with dihydroartemisinin-piperazine plus primaquine presented high relation with malaria cases in Grande Comore (RR=0.93, p value=0.00034). None relation was observed in Anjouan between malaria cases and control actions.

Environmental factors

A PCA can discriminate the islands by using environmental variables. Grande Comore presents a strong positive correlation between the average incidence of malaria and the proportion of urban lands ($r = 0.79$; $p < 0.0001$), bare lands ($r = 0.59$, $p < 0.01$) and the population density ($r = 0.64$ $p < 0.001$). Moheli presents also a strong positive correlation between the average incidence of malaria and the average of NDVI ($r = 1.0$, $p < 0.01$) and a strong negative correlation with the urban lands ($r = -1.00$; $p < 0.01$). None relation was observed between environmental factors and the average incidence in Anjouan.



Conclusion

The decrease of malaria has been driven by different control actions organized by the Government. Locally, some environmental factors seem also to influence the occurrence of malaria, as suggested by the relation between malaria and urban lands in Grande Comore and NDVI in Moheli.

The Comorian Government targets the total elimination of malaria at the end of 2016. Actually, Moheli and Anjouan are classified in elimination phase and Grande Comore in control phase.

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