

Mapping Malaria Risk in Dakar, Senegal

Marion Borderon, Sébastien Oliveau

When entomology meets social sciences...

Framework of the research

- ANR ACTU PALU -

- interdisciplinary project
- Data & method Social and behavioural surveys & thick blood smears (TBS) assesement (epidemiological data) in 50 areas in Dakar in 2008
- Specific geographical goal to highlight and describe the urban contexts that have contributed to the resurgence and development of malaria in Dakar

- Project on Malaria transmission in Dakar -

- interdisciplinary project
- Data & method Extensive entomological survey that was conducted in 45 areas in Dakar from 2007 to 2010
- Goal Mapping the risk of *Anopheles gambiae s.l.* densities using remotely-sensed environmental and meteorological data in Dakar

□ Perspective about malaria in Dakar:

2 substantial projects in the same place at the same time

Same object, same place, same time

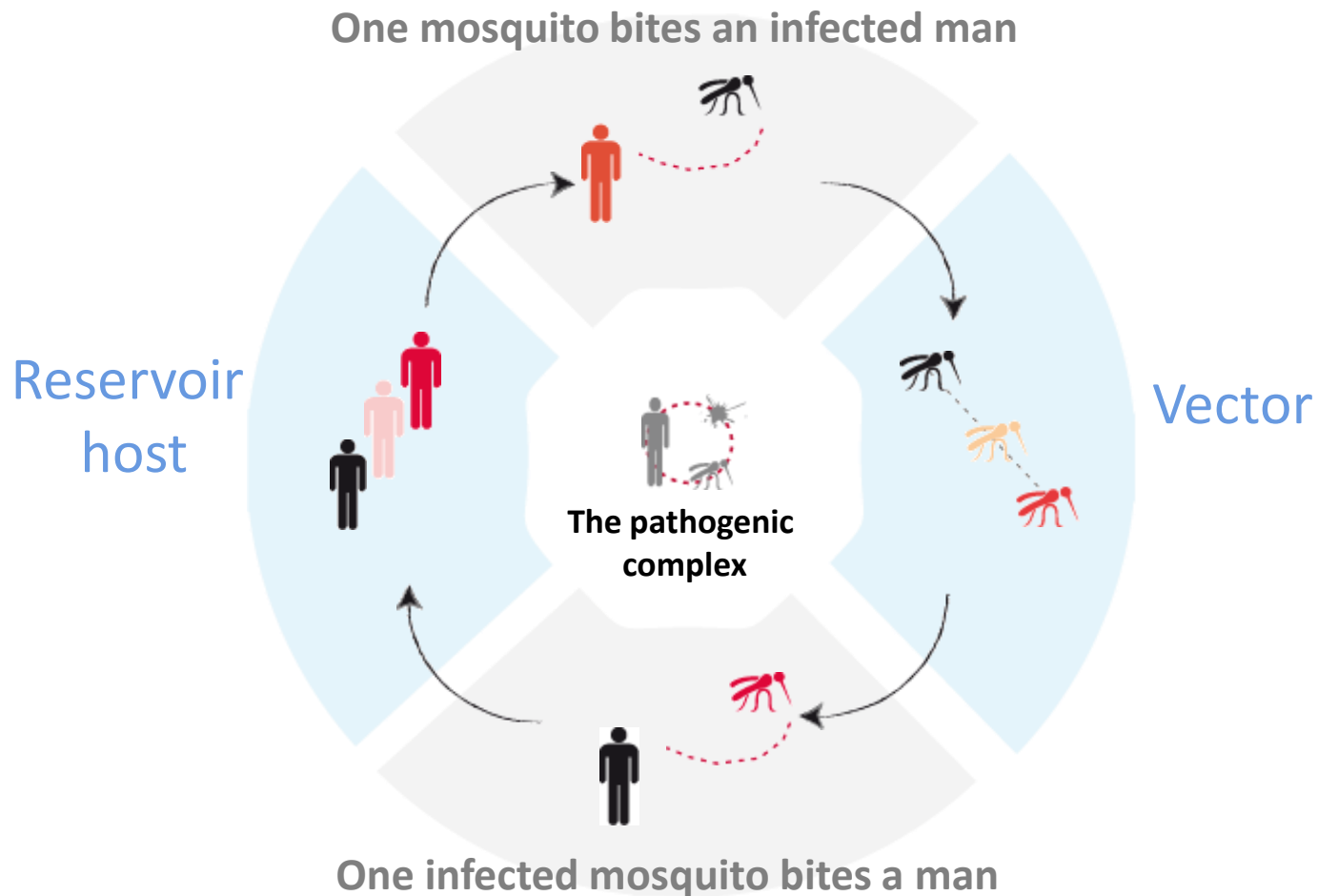
THE STUDIED SITE

THE FOUR CITIES OF THE DAKAR METROPOLITAN AREA

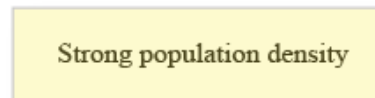


Marion Borderon UMR 7300 ESPACE 2012

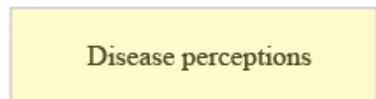
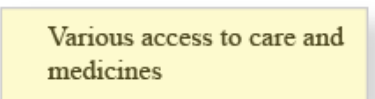
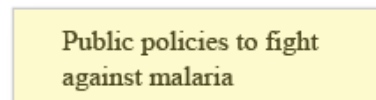
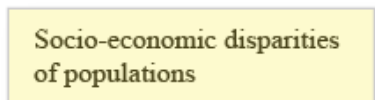
Malaria in an urban area: Dakar (2008)



The epidemiological chain of malaria

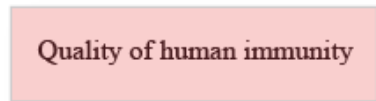


Limited anophelian development



Uneven exposure of hosts regarding vectors

Vulnerability of some populations to the parasite transmission



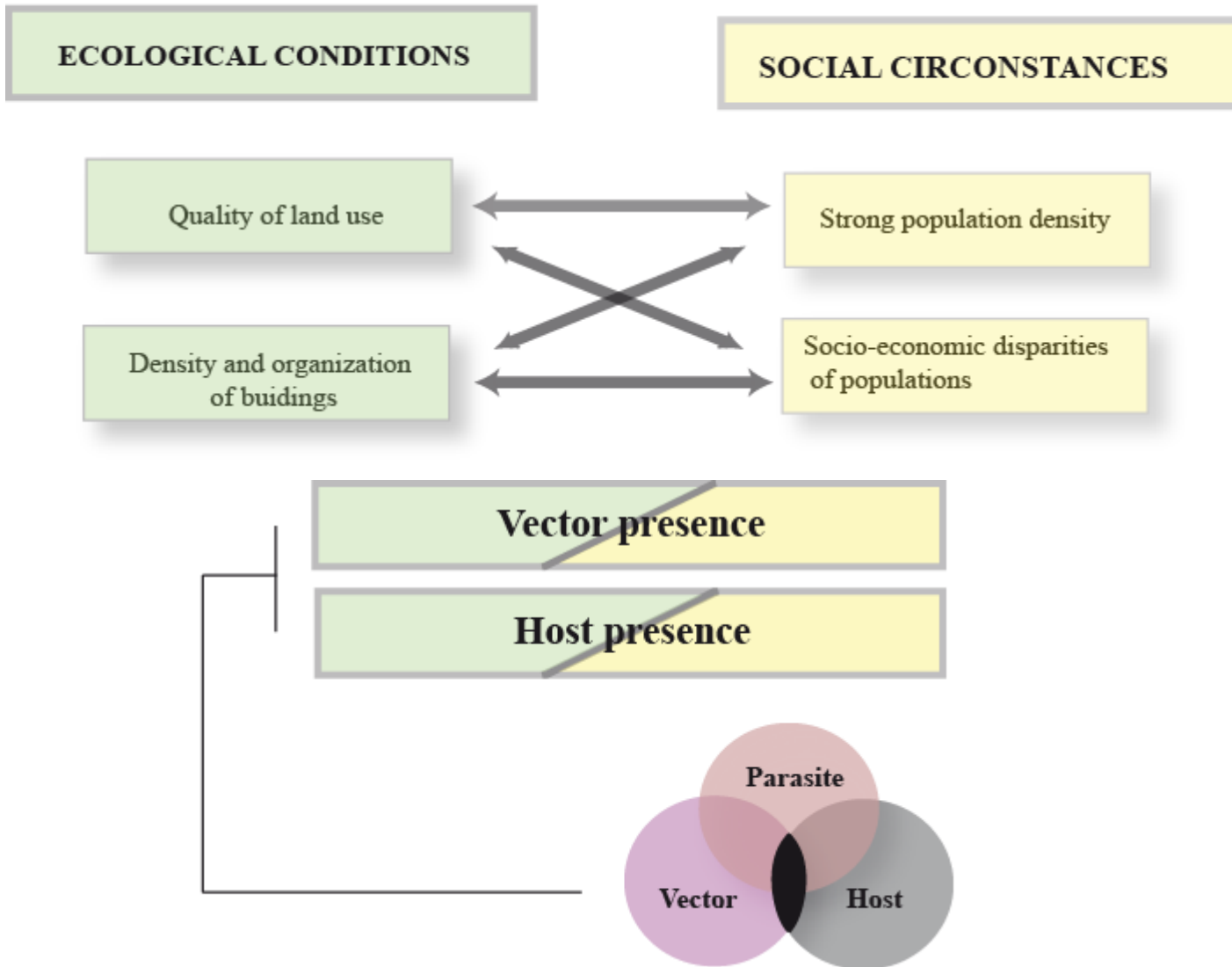
No or just little immunity with delayed acquisition



Low malaria exposure in general but a very heterogenous transmission



The simplified socio-pathogenic system of urban malaria

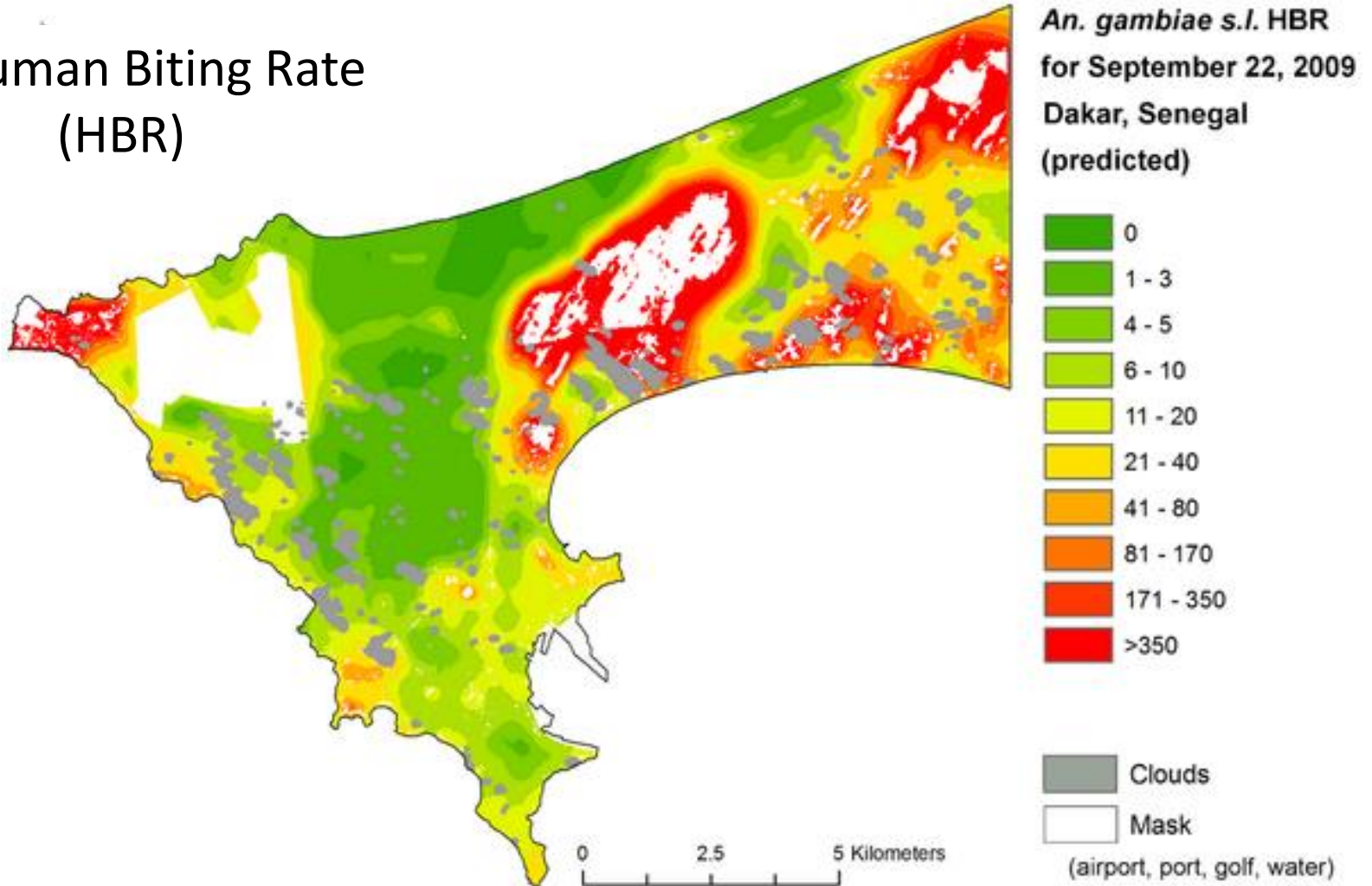


An example of socio-ecological overlapping

Type	Spatial coverage	Time frame	Source
Landcover data with 2.5 m raster size	Region of Dakar	2007 - 2008 - 2010	satellite data from SPOT 5
Multitemporal analysis of landcover	Maps on all the region of Dakar	1988 – 2008	Centre de Suivi Ecologique (CSE)
Socioeconomic variables	2000 CDs (Census Districts)	2002	Census ANSD
Prevalence Rate	112 CDs	2008	ANR ACTUPALU

Materials

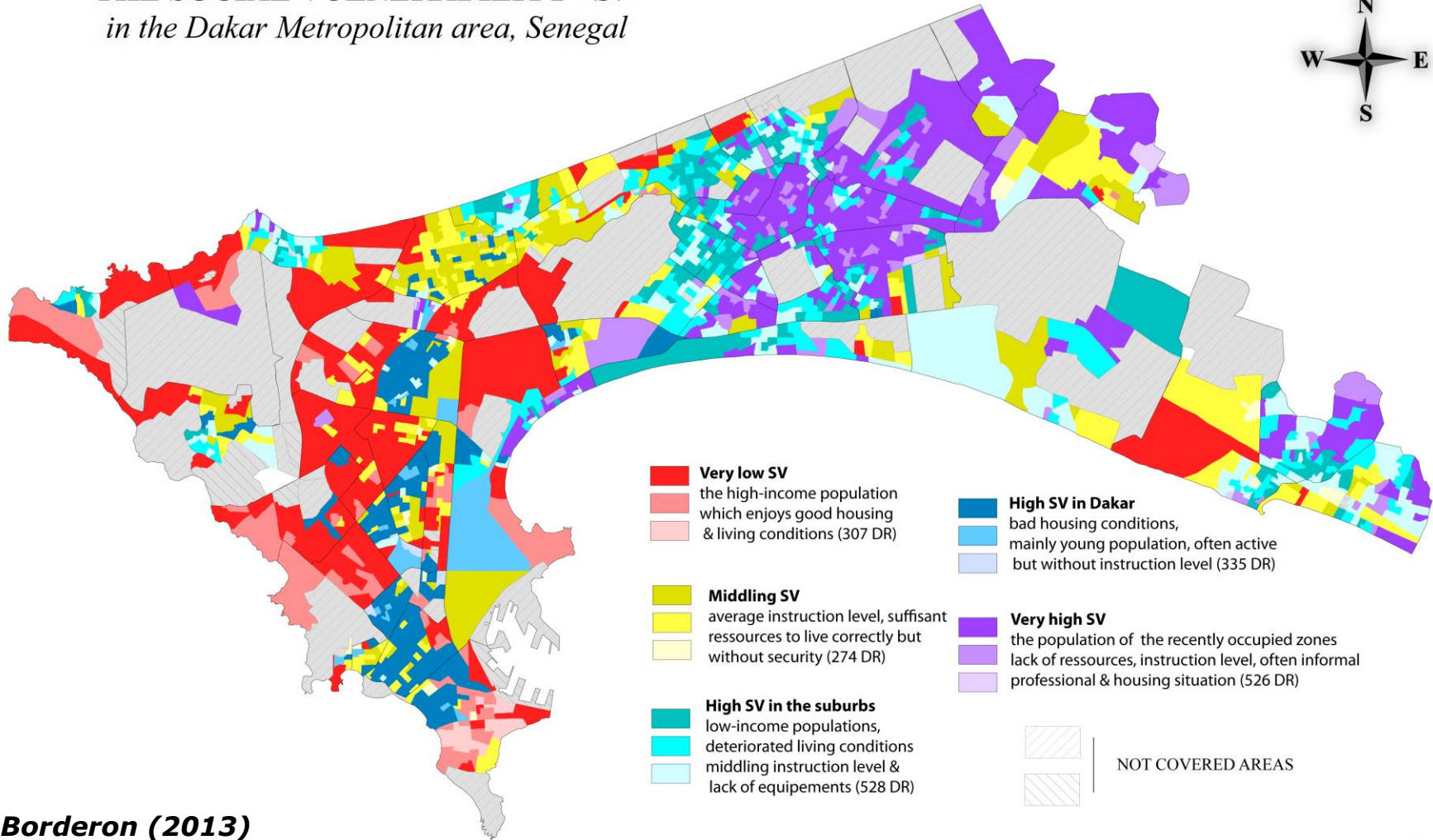
Human Biting Rate (HBR)



Machault V et al. (2012)
published in Plos one

Final models (1/2)

THE SOCIAL VULNERABILITY - SV- in the Dakar Metropolitan area, Senegal



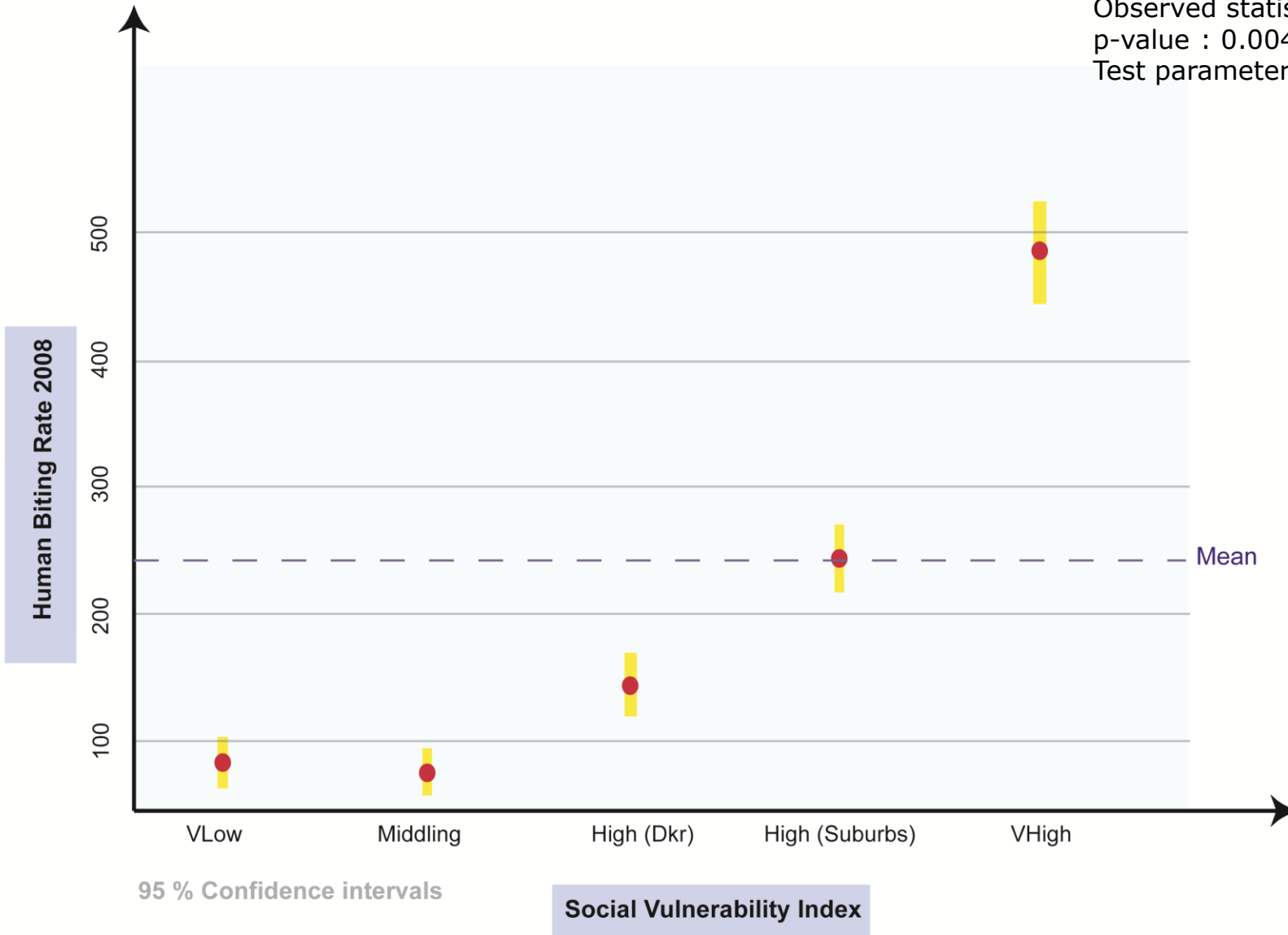
Borderon (2013)
published in UNU-EHS

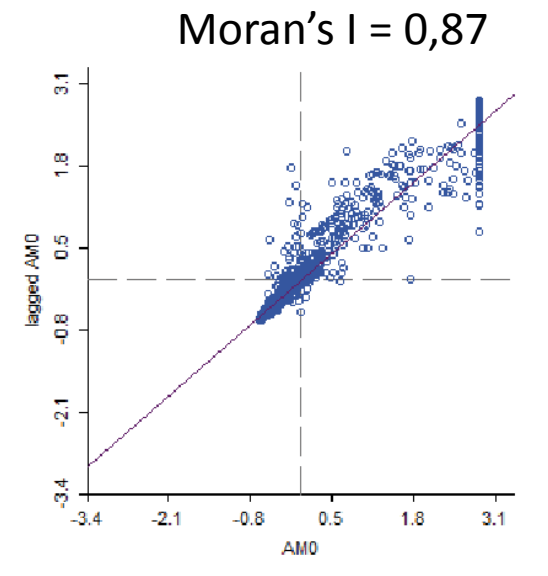
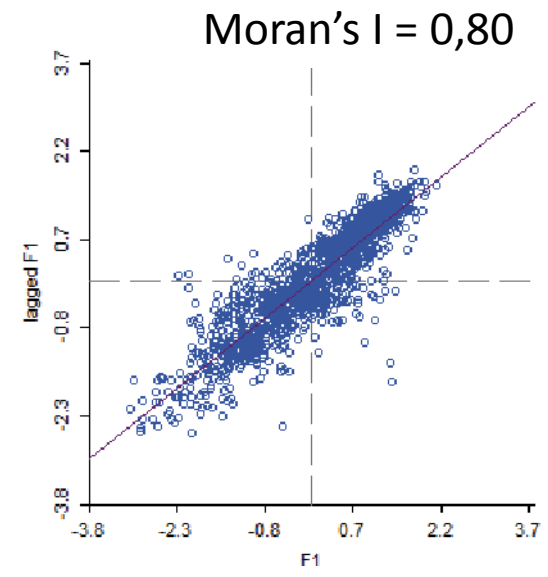
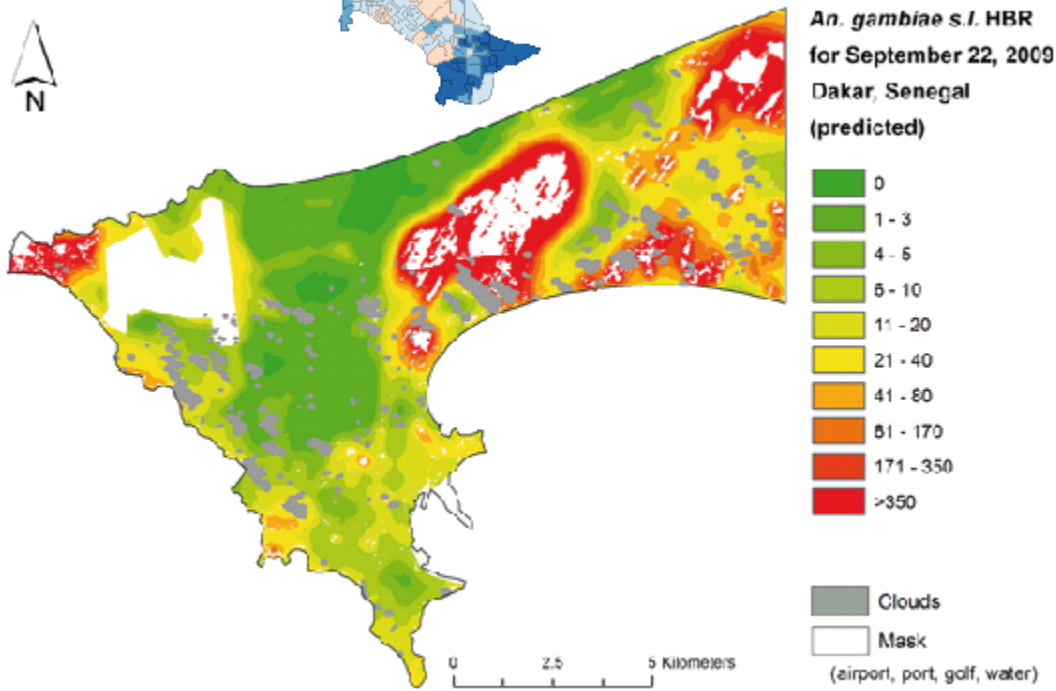
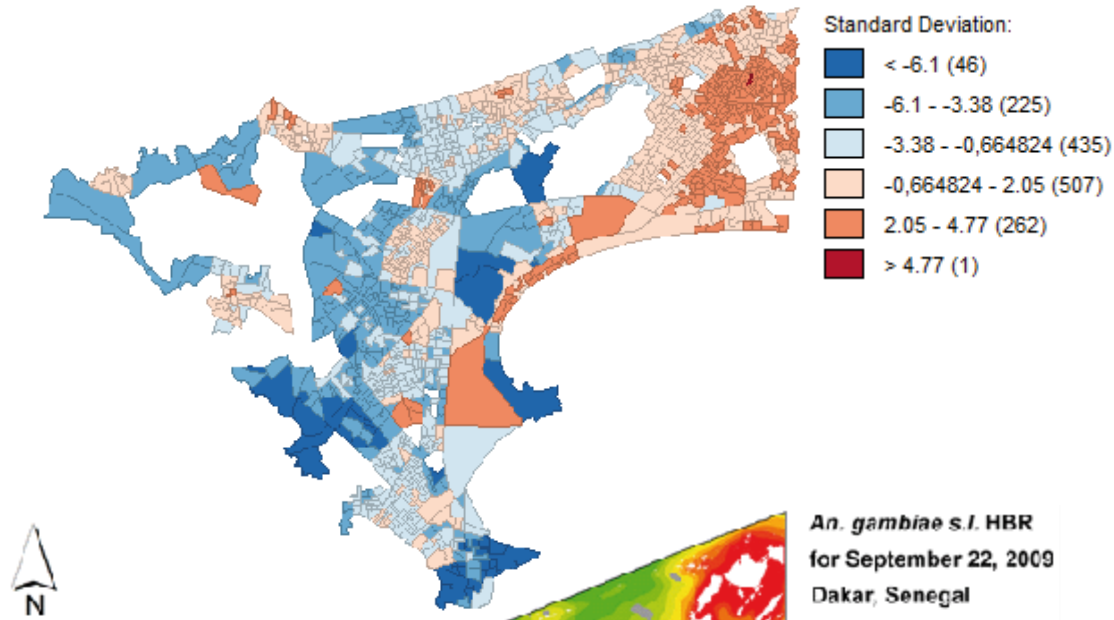


Kilometers

Final models (2/2)

Kruskal-Wallis rank sum test :
Observed statistics: 15.0
p-value : 0.0046
Test parameters : 4





The horizontal relationship at the district scale

Luc Anselin's BiLISA

$$I_i = \frac{\sum_j w_{ij} (z_i - \bar{z})(u_j - \bar{u})}{\sum_i (z_i - \bar{z})^2}$$

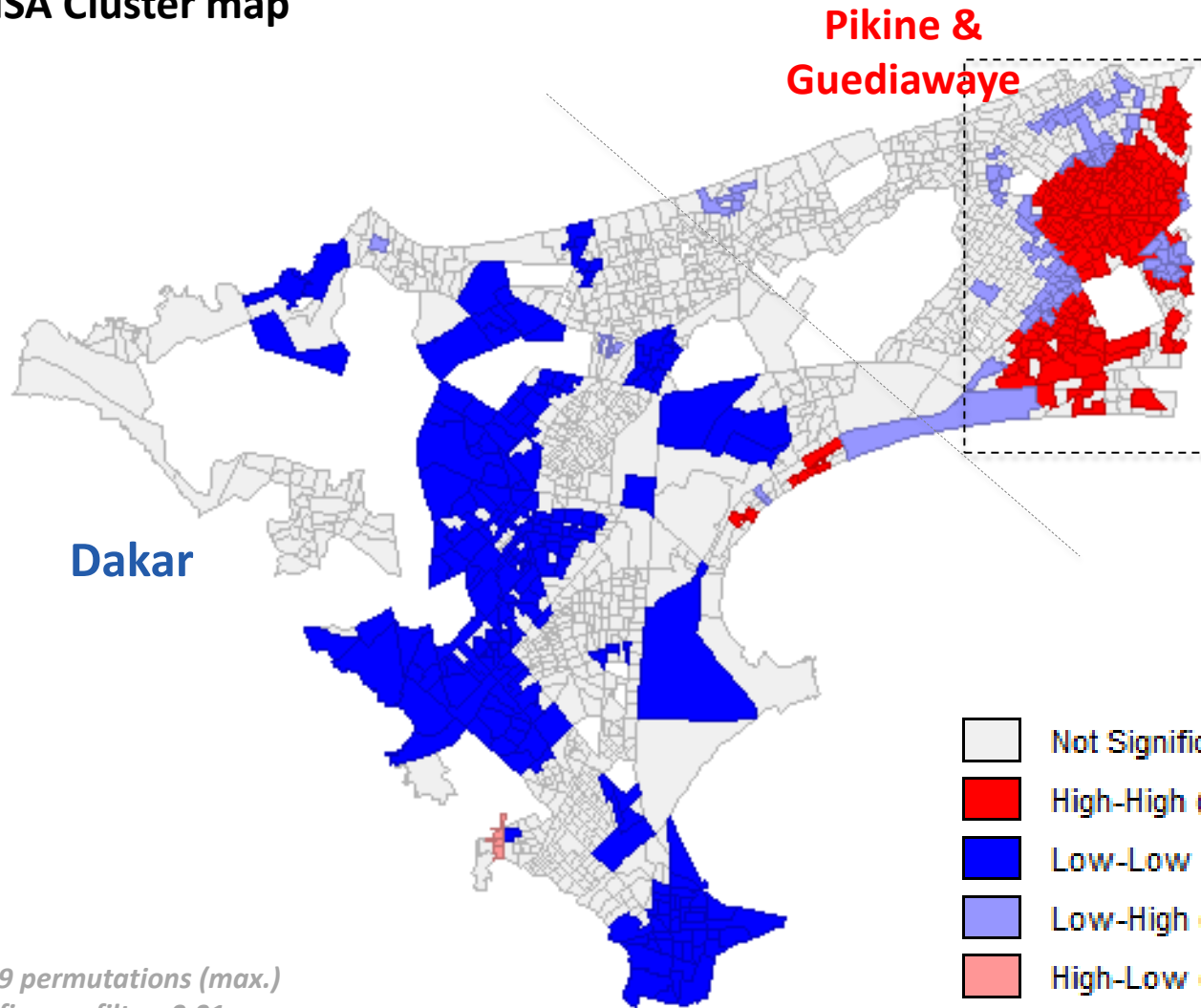
W_{ij} : contiguity matrix

Z_j : value of the Z variable for the i individual

U_j : value of the U variable for the j individual

Measuring the spatial link
between HBR and social vulnerability

BiLISA Cluster map



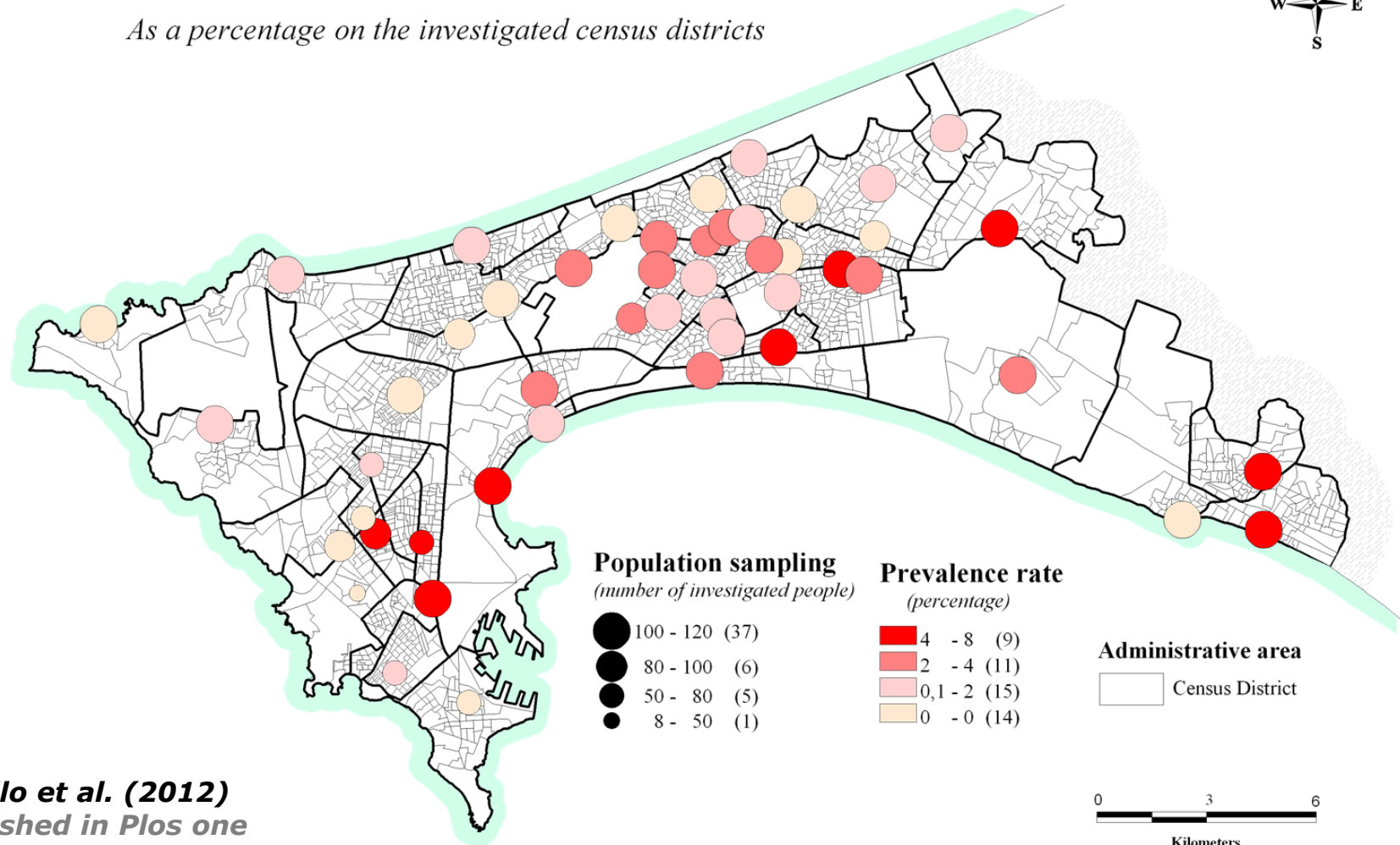
42% of the entomological vulnerability (HBR) is explained by the social around (Human vulnerability)

*49999 permutations (max.)
Significance filter: 0.01
First order contiguity*

Spatial Risk Approach by BiLISA

Malaria parasite prevalence in Dakar (Senegal)

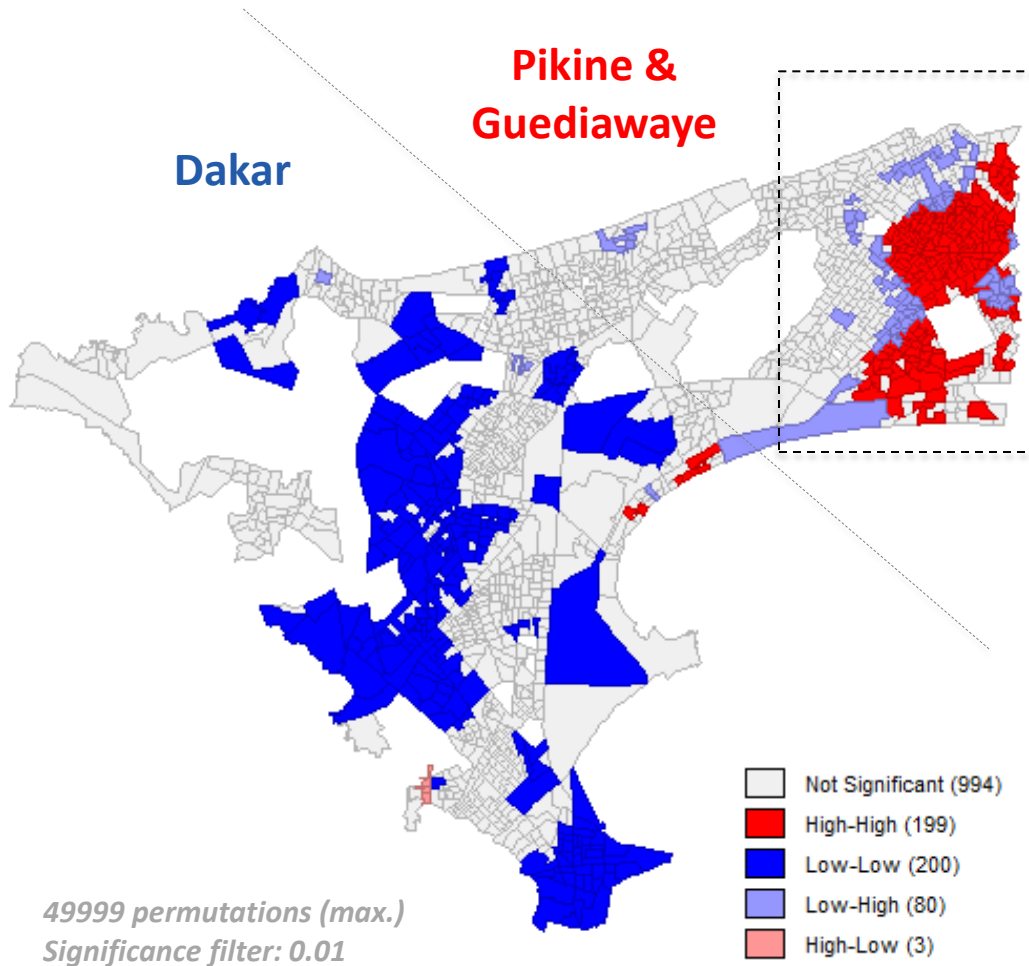
As a percentage on the investigated census districts



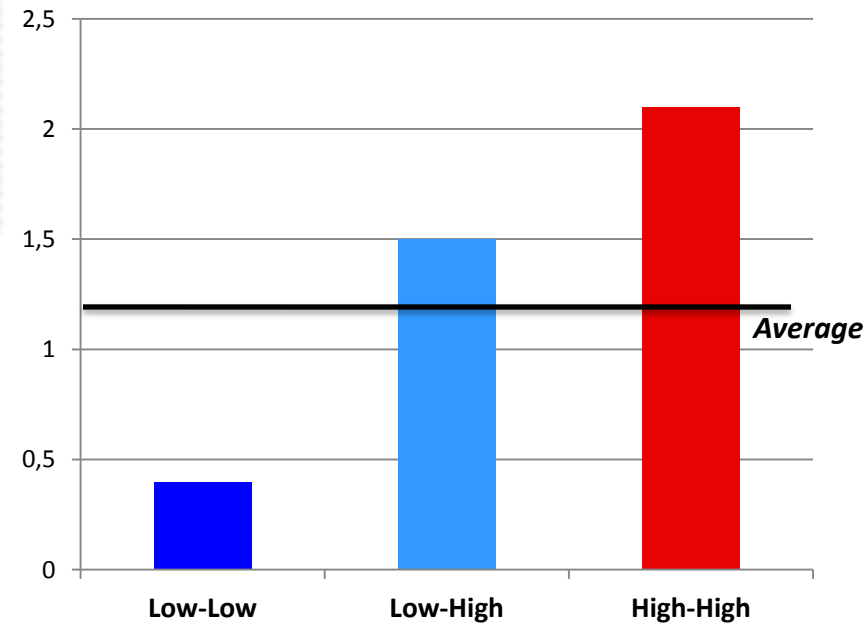
Diallo et al. (2012)
Published in Plos one

Epidemiological data – data used for validation

BiLISA Cluster map



Prevalence rate by types



Prevalence rate and spatial co-location

Conclusion

Almost half of the location of Anopheles is explained by the social vulnerability of human individuals.

Suggested explanations:

- ✓ **Vulnerable people have less choice of location,** they live on /near the floodplain or wetlands- favorite landscapes for mosquitoes.
- ✓ **Vulnerable people are less able to protect** themselves from mosquitoes, which can more easily take blood meals and breed.
- ✓ **Non-vulnerable people are more able to control their environment.**

Conclusion

Major contributions of the study:

- Recognition and statistical demonstration of the link between the physical and social attributes of the urban landscapes.
- Risk mapping of malaria transmission with typologies of urban areas at risk (at the district scale) - (in logic with the Hyogo Protocol).

Thank you for your attention

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