Rodents and public health in Niamey, Niger:

Community ecology
Population genetics
SIG and geostatistics

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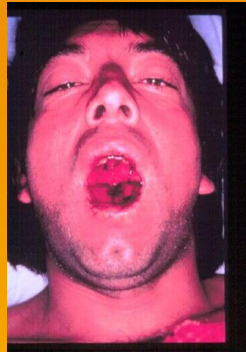Caroline TATARD

Rodents and public health
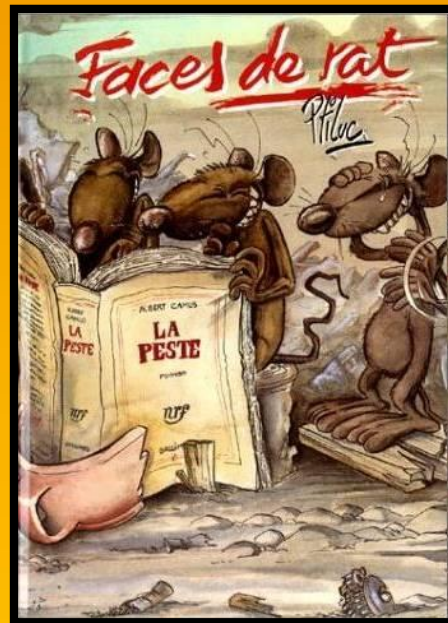

Leptospira
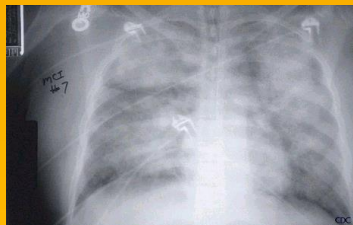➔ leptospirosis

Yersinia pestis
➔ plague

Rickettsia, Orientia
➔ typhus

Arenaviruses
➔ LCMV, Lassa, etc

Hantaviruses
➔ Hantaan, Sin Nombre, etc

Leishmania
➔ leishmaniases

Trypanosoma
➔ trypanosomiasis

Urban rodents and public health

Increasing urbanization

Increased rodent/human interactions

Dominance of highly competitive and generalist rodent species (*i.e.* invasive species)

Impacts on public health

❖facilitated pathogens' circulation
❖epidemics
❖emergence processes through pathogens import, hybridization, etc

Higher risks in cities from developing countries due to …
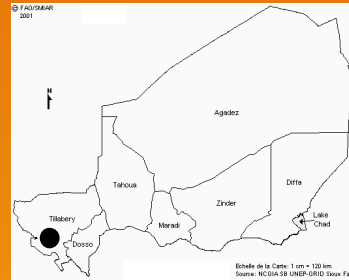

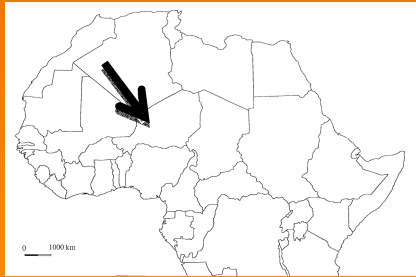❖ **overcrowding**

❖ **insalubrity**

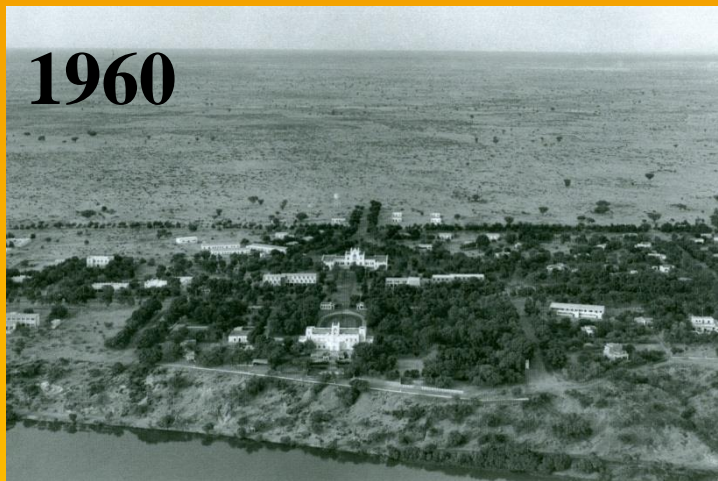❖ **reduced access to medical care**

❖ **promiscuity with other animals**
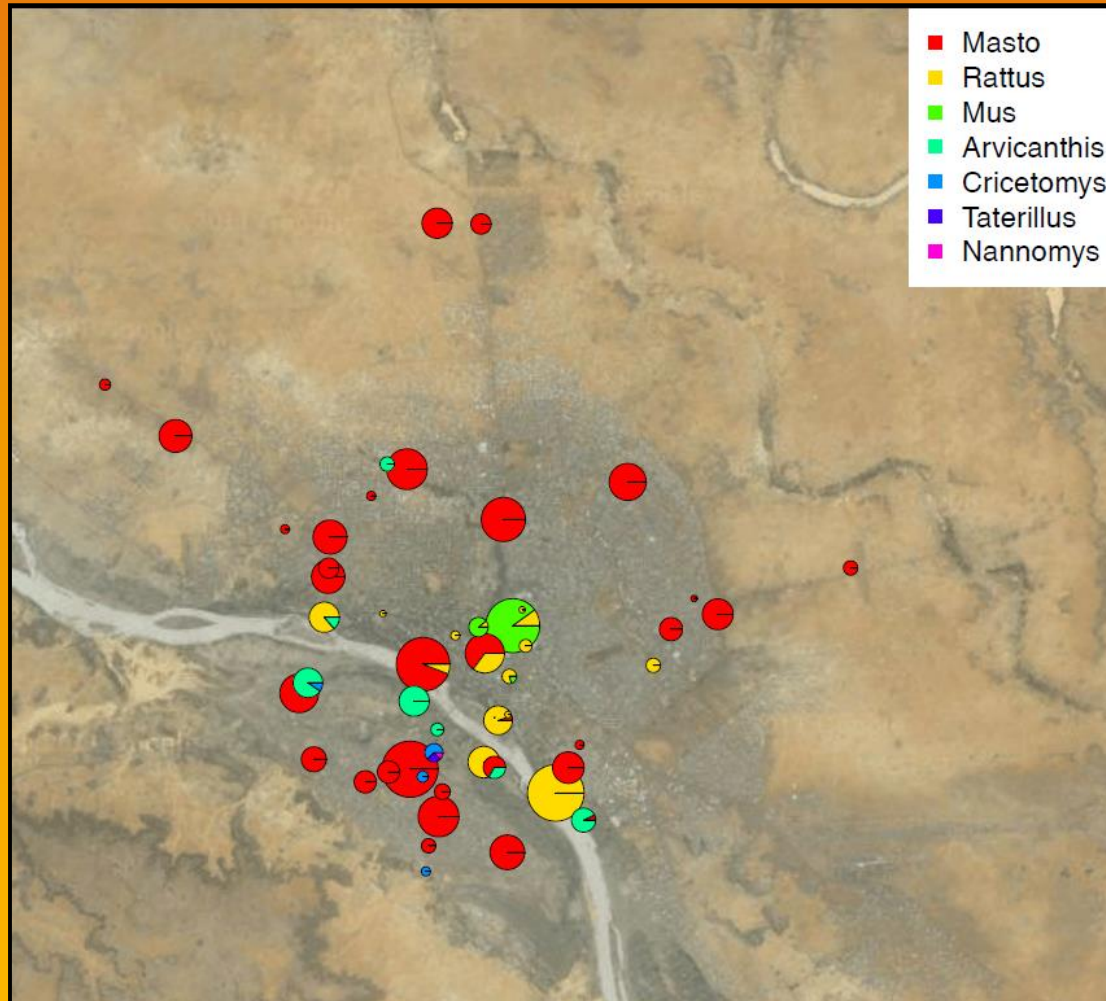
Niamey, capital town of Niger

- Created *ex nihilo* ~115 years ago
- 1.1 inhabitants (data 2009)
- Superficy >12,000 ha

1960

2009

Extensive urban and demographic growth during the last five decades

Rodents from Niamey

241 trapping sites
2 types of traps
14,500 night-traps

987 rodents
8 species
2 invasive species

In order to avoid misidentifications, all taxonomic assigments were confirmed using molecular methods (genotyping, sequencing, PCR-RFLP and/or karyotyping).

Arvicanthis niloticus
Cricetomys gambianus
Nannomys hausa
Taterillus gracilis
(*Xerus erythropus*)

One assemblage of « rural-like » species only found in fallow lands and cultivated areas of the city.

**Another assemblage of strictly
commensal species
infeoded to human constructions
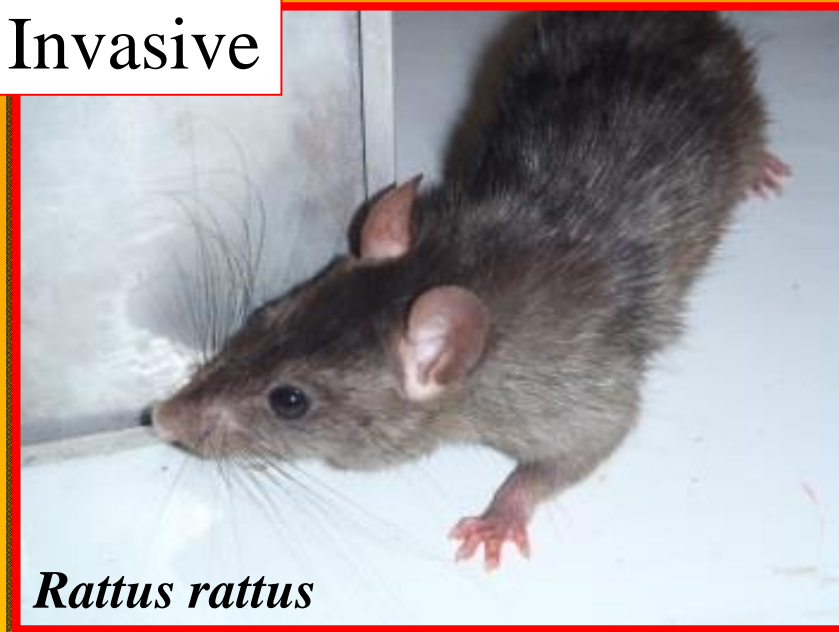(houses, markets, coach stations, etc).**

Mastomys natalensis — Native

Mus musculus — Invasive

Rattus rattus — Invasive

# Rodent-borne human pathogens in Niger

Molecular survey of rodent-borne *Trypanosoma* in Niger with special emphasis on *T. lewisi* imported by invasive black rats

Gauthier Dobigny[a,b,*], Philippe Poirier[c], Karmadine Hima[a], Odile Cabaret[c,d], Philippe Gauthier[b], Caroline Tatard[b], Jean-Marc Costa[c,e], Stéphane Bretagne[c,d]

Trypanosoma spp. (including invasive ones)
Dobigny et al., 2011
Unpublished data
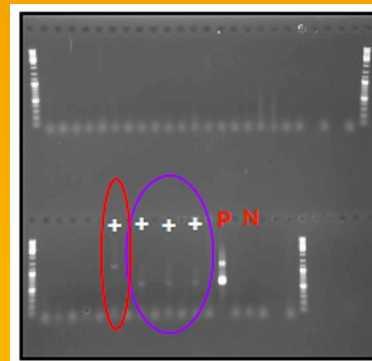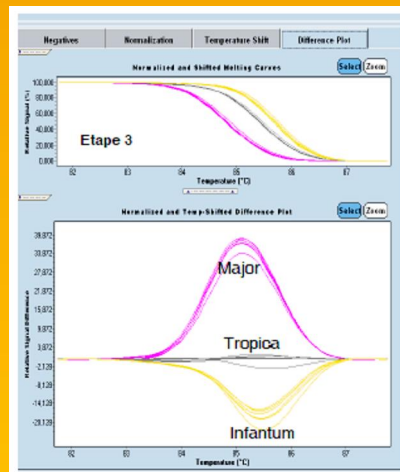
Leishmania spp.
Unpublished data
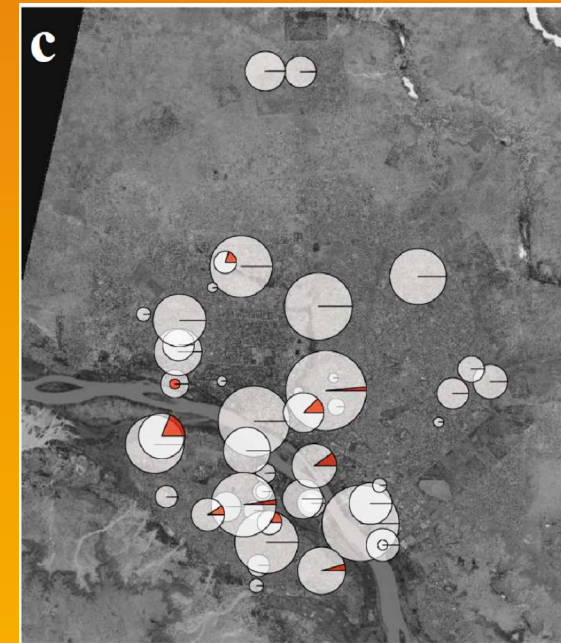
Toxoplasma gondii
Mercier et al., 2013

How may our data be helpful for
modeling rodent-borne pathogen
distribution at the city scale?

➢Can we characterize the urban landscape heterogeneity using landscape metrics?

➢Can we relate rodent occurrence and urban landscape?

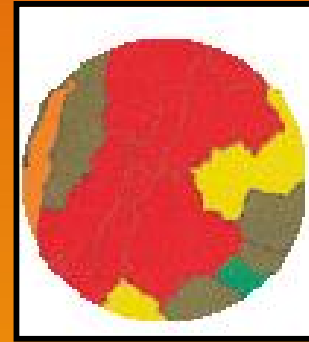➢Ultimatly, can rodent-borne pathogens be related to urban landscape?
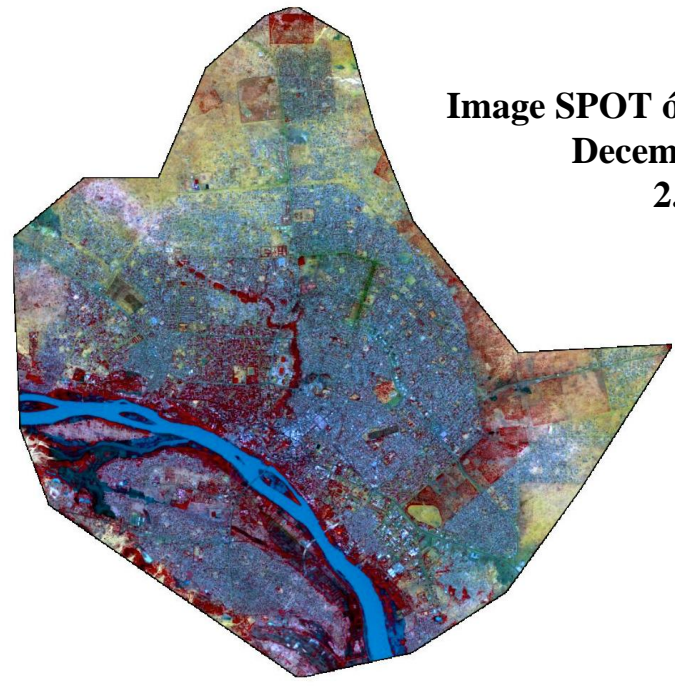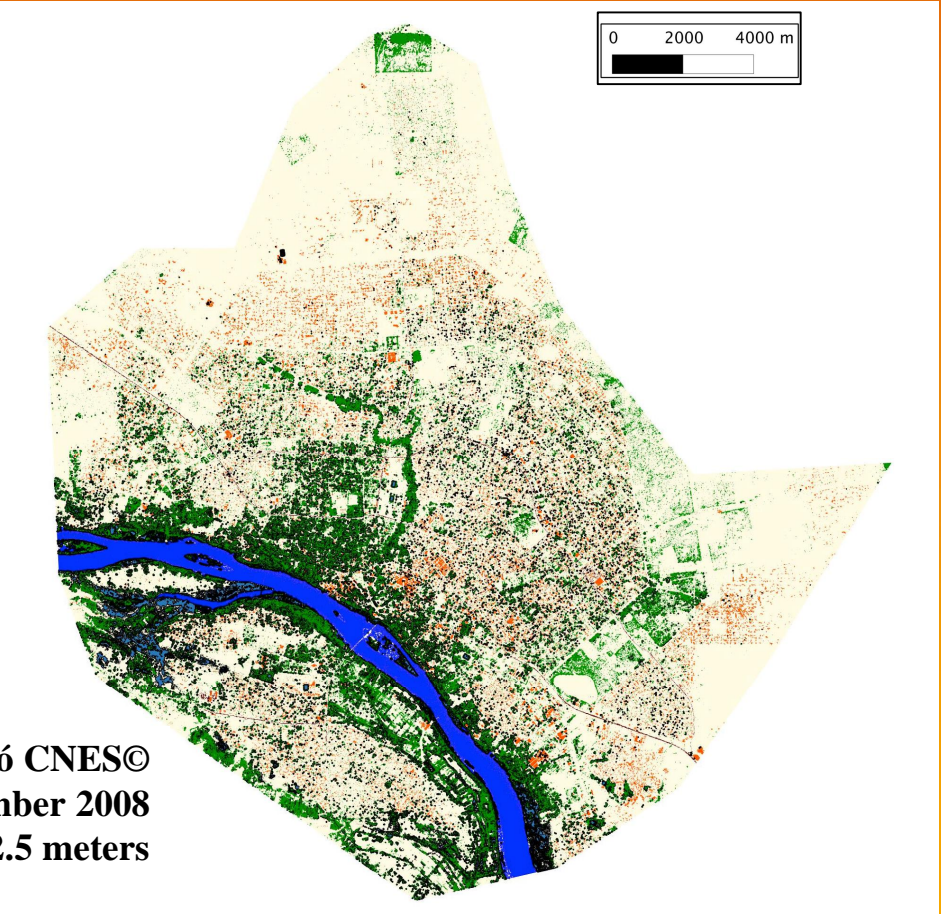
Image SPOT ó CNES©
December 2008
2.5 meters

<u>Geographic Information System</u>
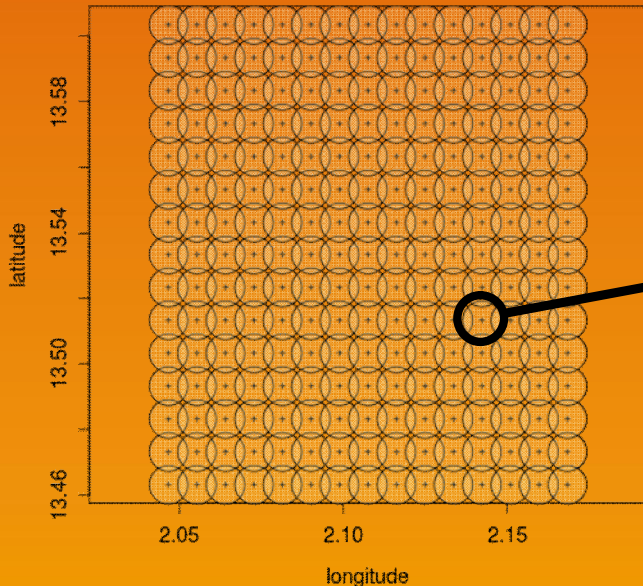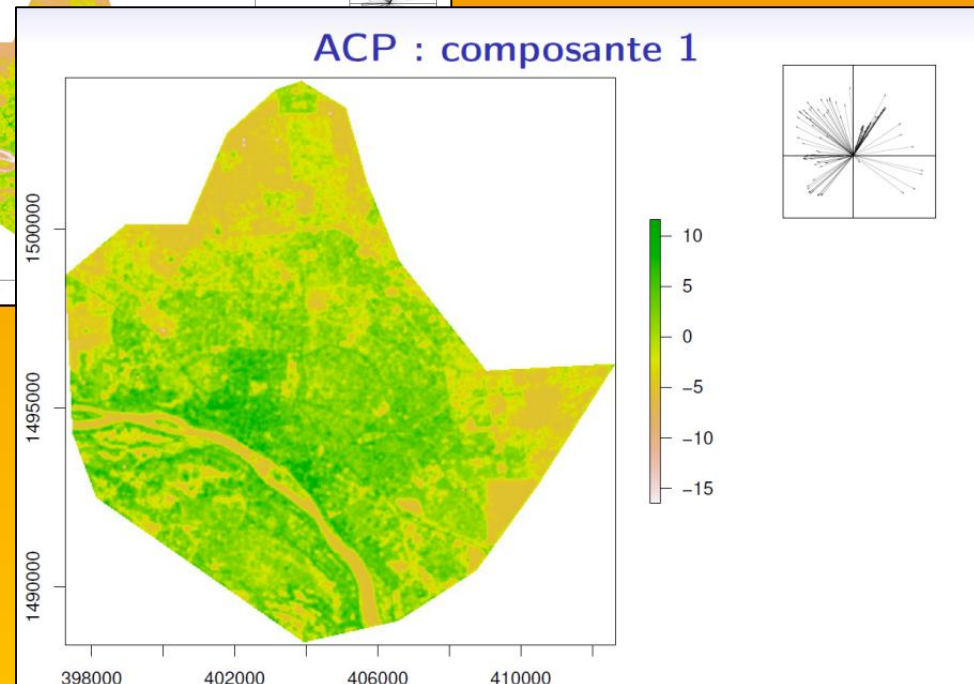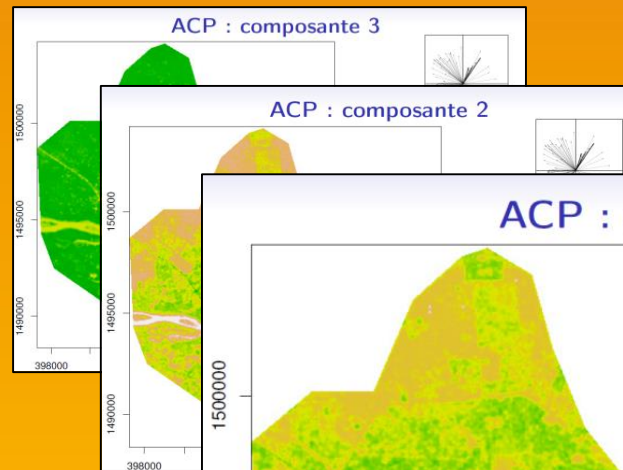
Extraction of « mini landscapes »
(N=55,160)

ÉArea & edge metrics
ÉShape metrics
ÉCore area metrics
ÉContrast metrics
ÉAggregation metrics
ÉSubdivision metrics
ÉIsolation metrics
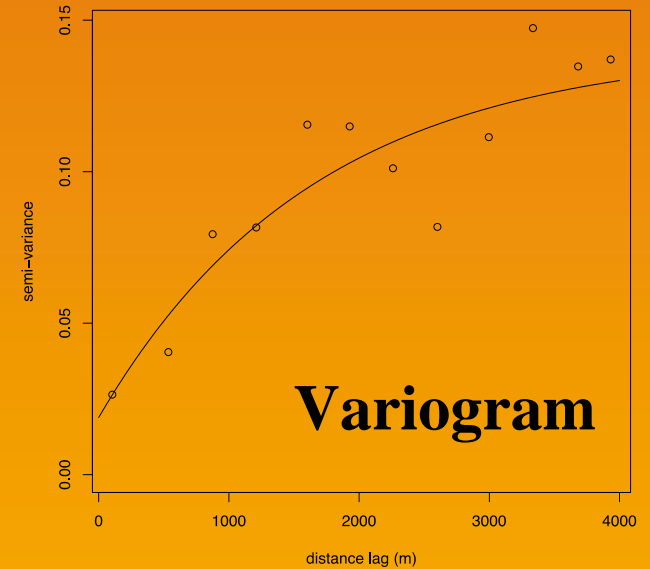ÉDiversity metrics

Principal
Component
Analysis

ACP : composante 3

ACP : composante 2

ACP : composante 1

**Landscape metrics
provide an accurate
picture of the urban
landscape of Niamey**
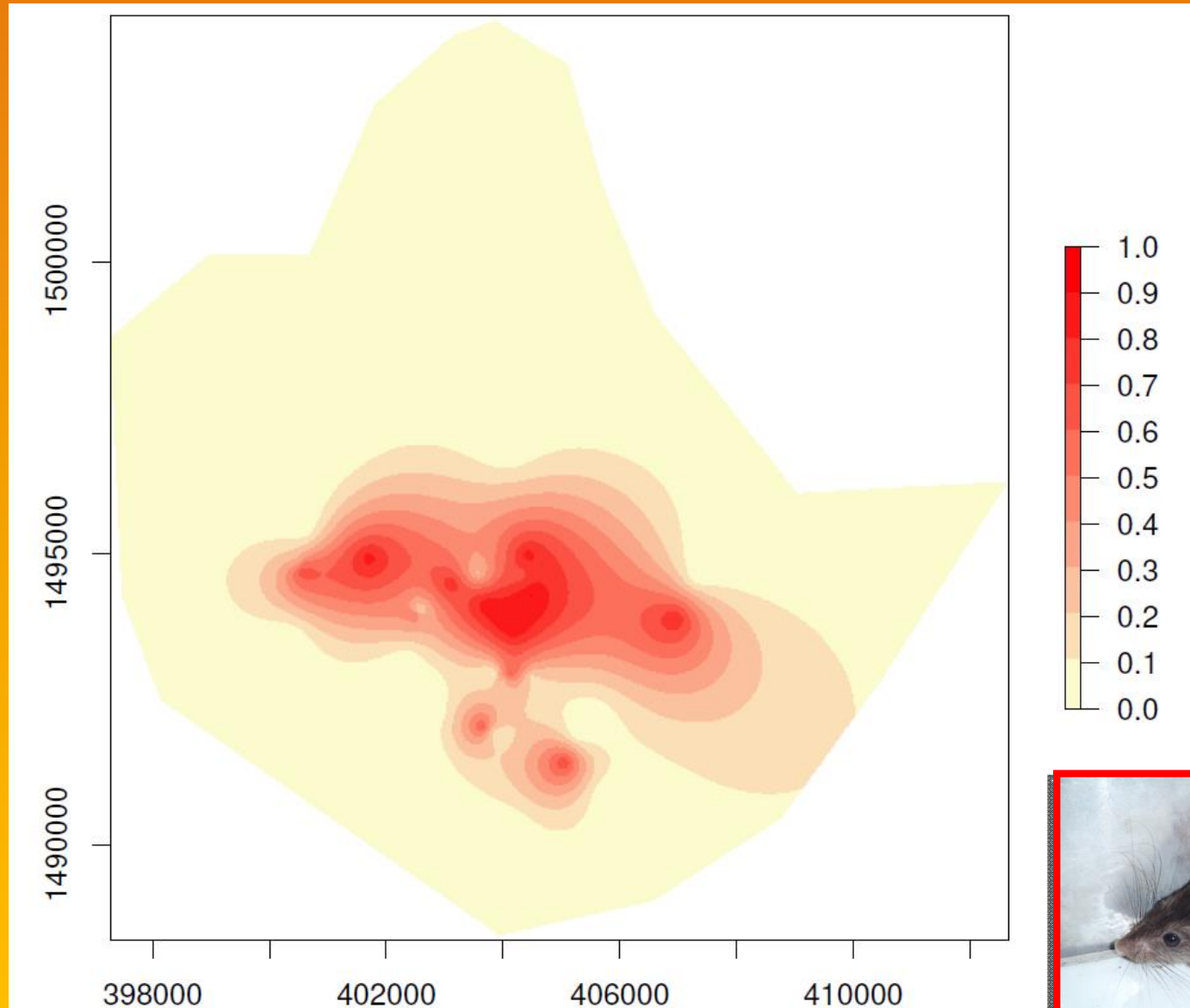
Probability maps of rodent species occurrence

N=241 trapping sites

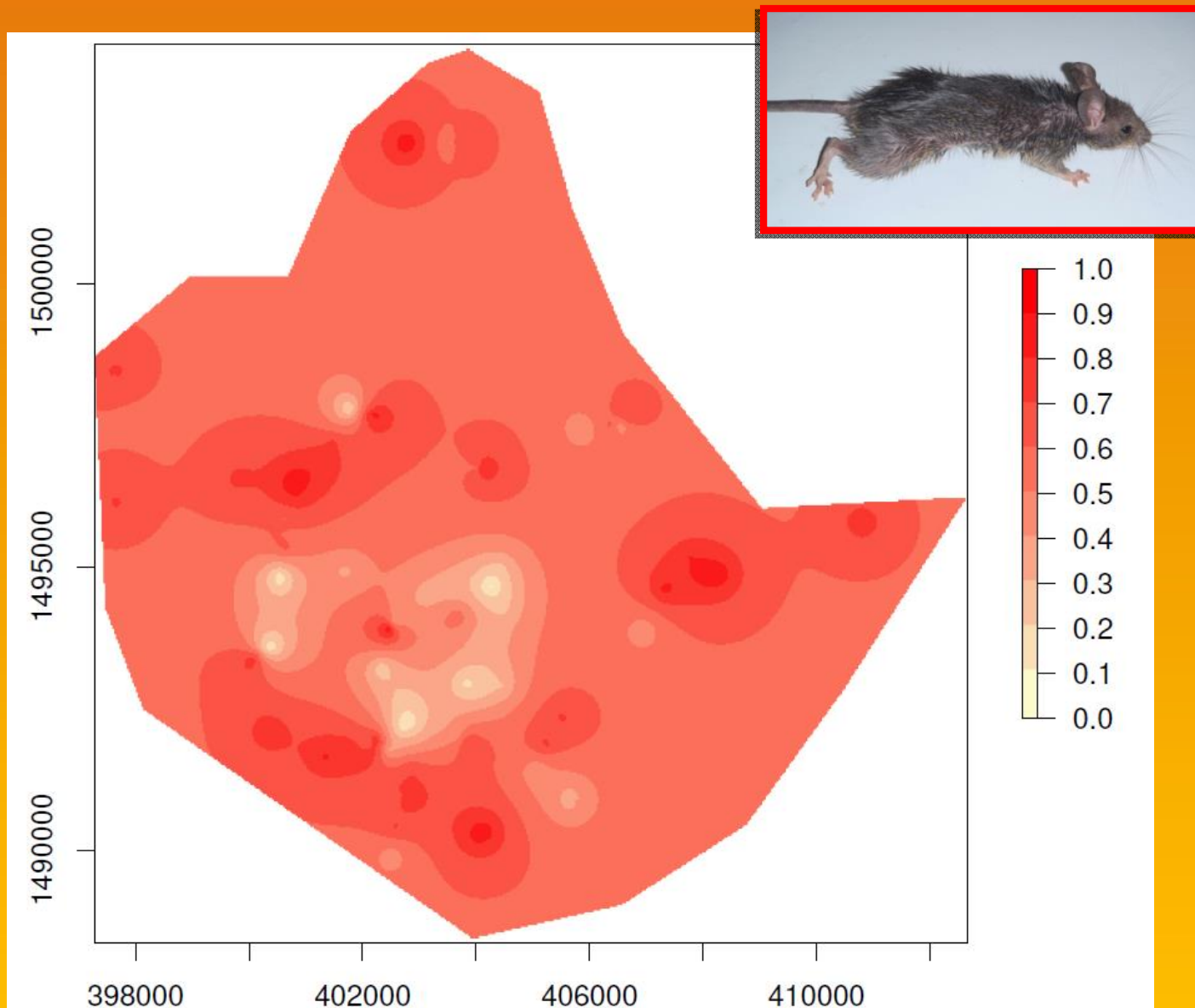**Présence / absence** →

Variogram
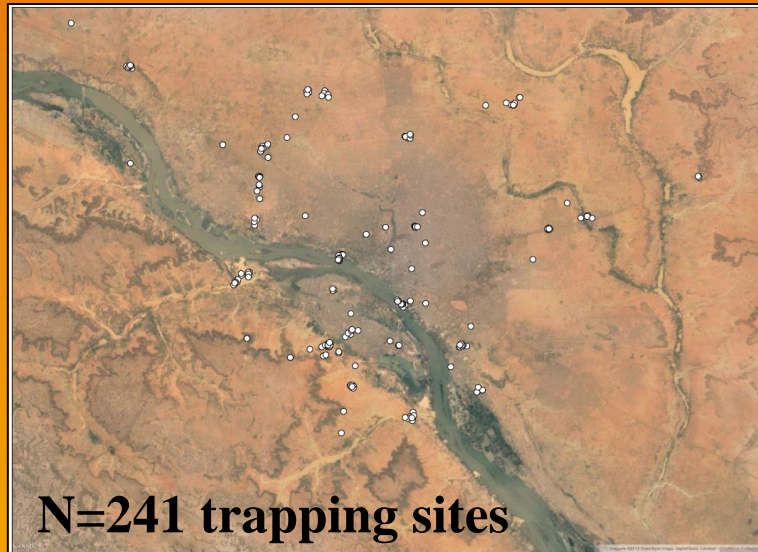
Optimal linear interpolation (i.e. kriging)

Probability of presence/absence at each point
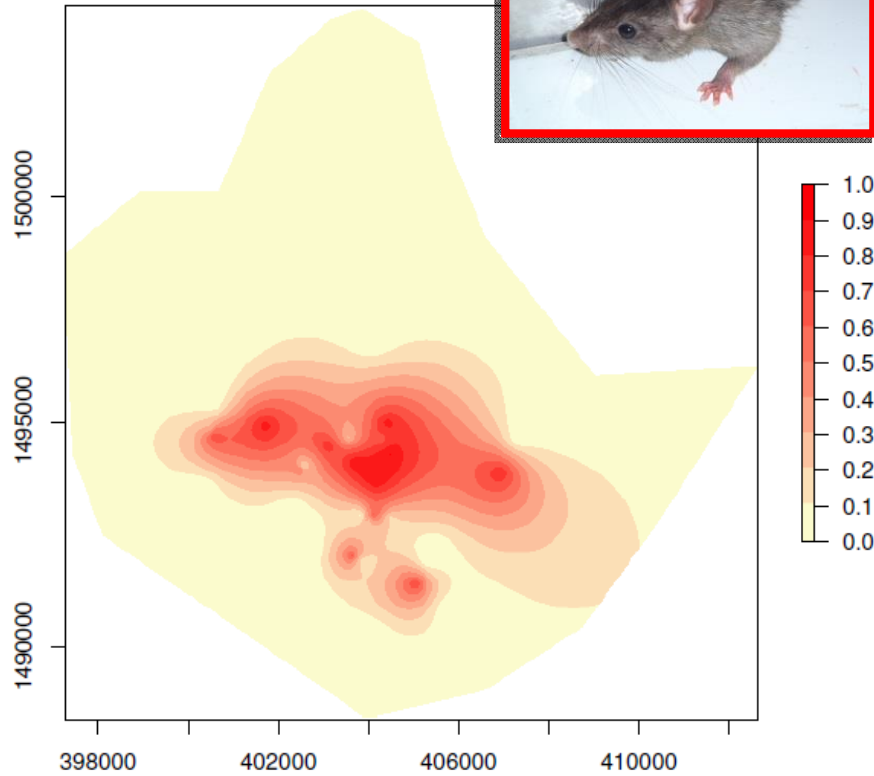
Probability map of *Rattus rattus* occurrence in Niamey

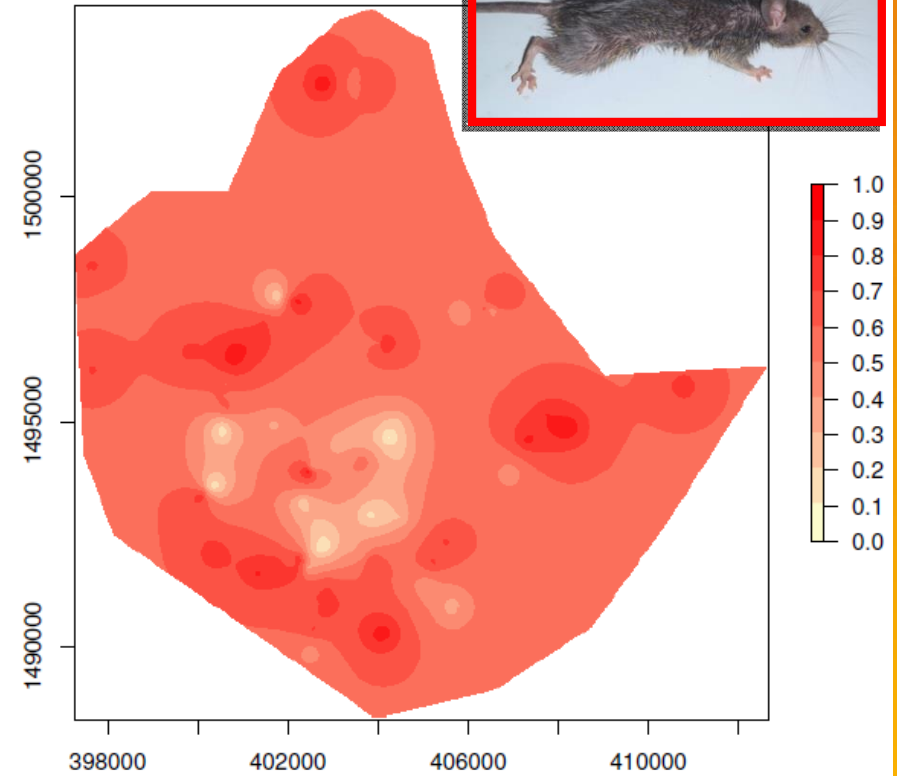# Probability map of *Mastomys natalensis* occurrence in Niamey

Clear spatial segregation (p<0.05)
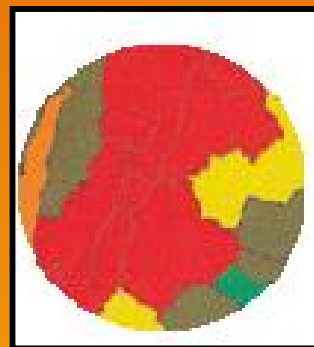
Invasive *R. rattus*

Native *M. natalensis*

NB: This confirms co-occurrence analyses (all p<0.004), but extents the results to an explicitly spatialized framework.
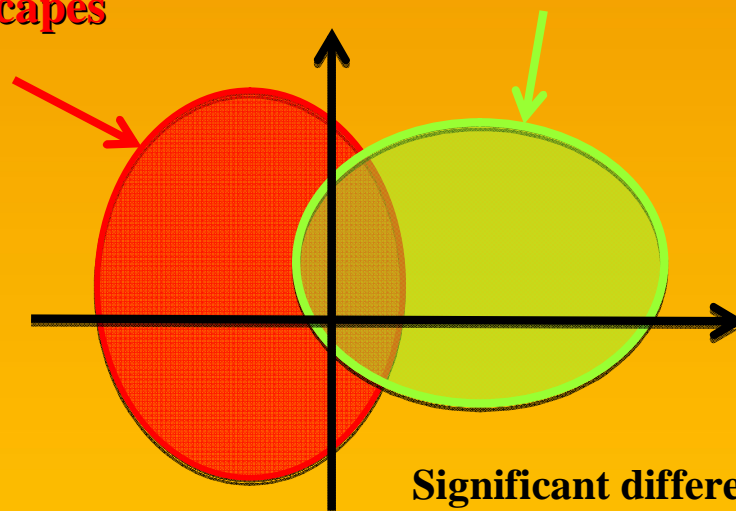
Rodents occurrence and landscape metrics

N=241 mini landscapes

N=241 trapping sites

PCA

Mini-landscapes without rats

Mini-landscapes with rats

Localities with and without rats correspond to divergent landscape structures

Significant difference (p<0.001)

Population genetics of the invasive black rat
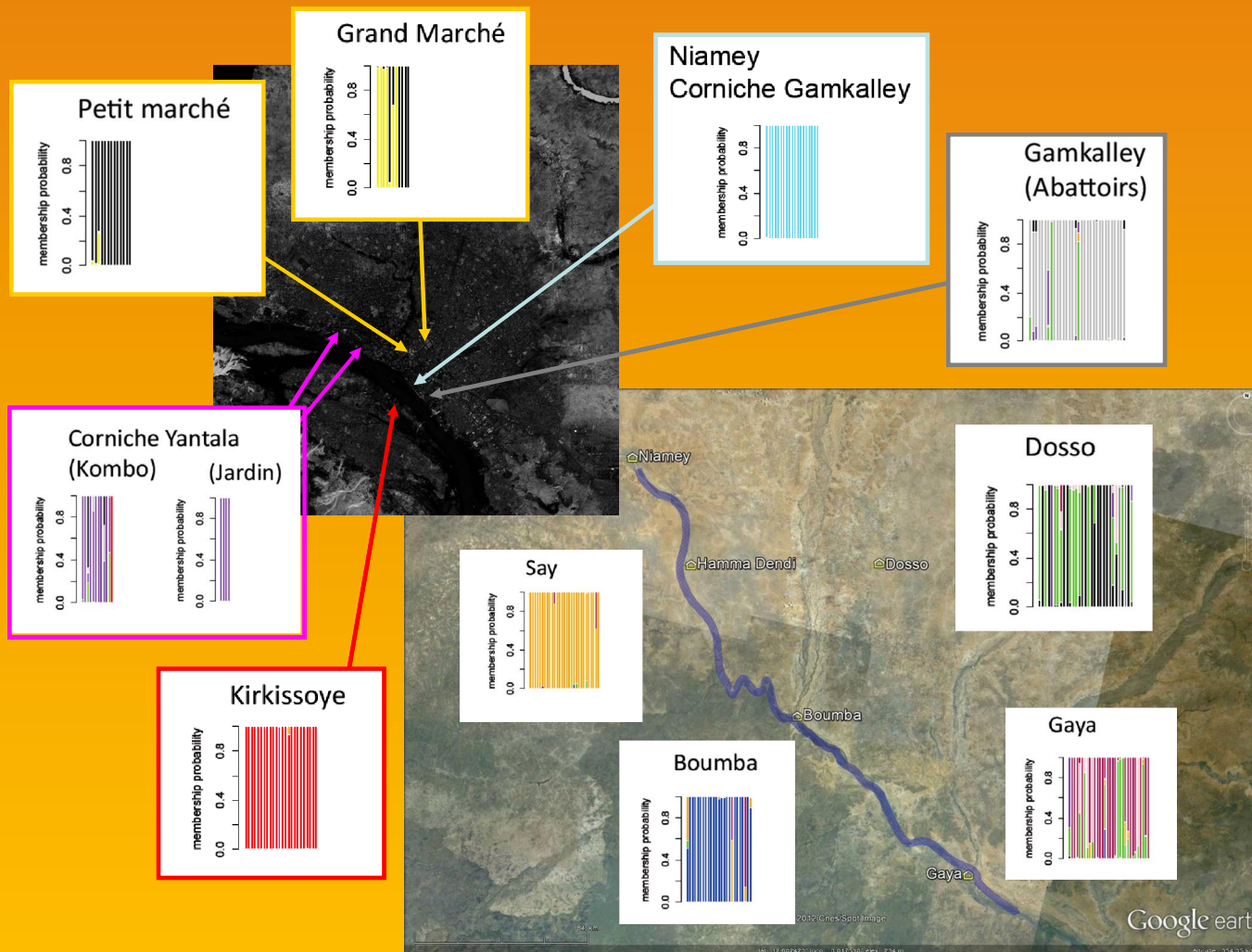
N=232 individuals

17 microsatellite loci
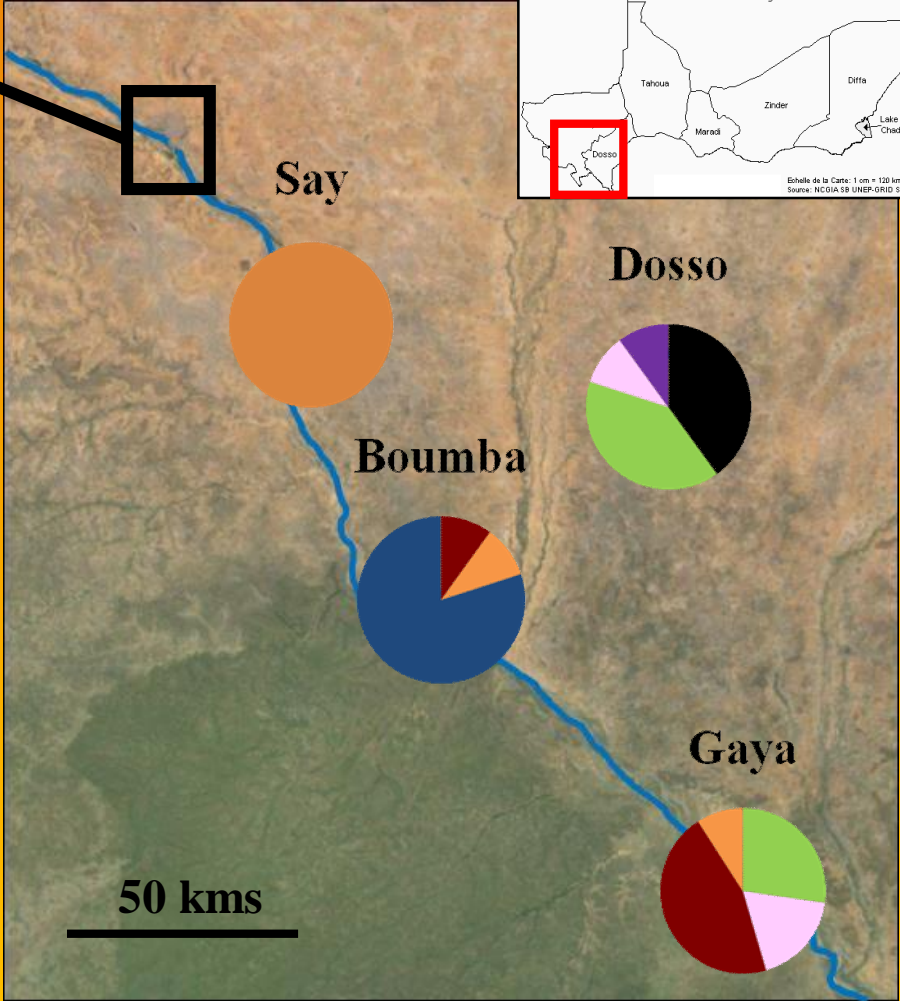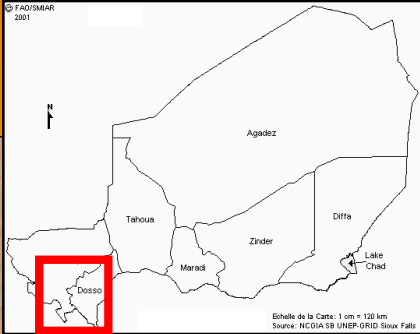
Population genetics
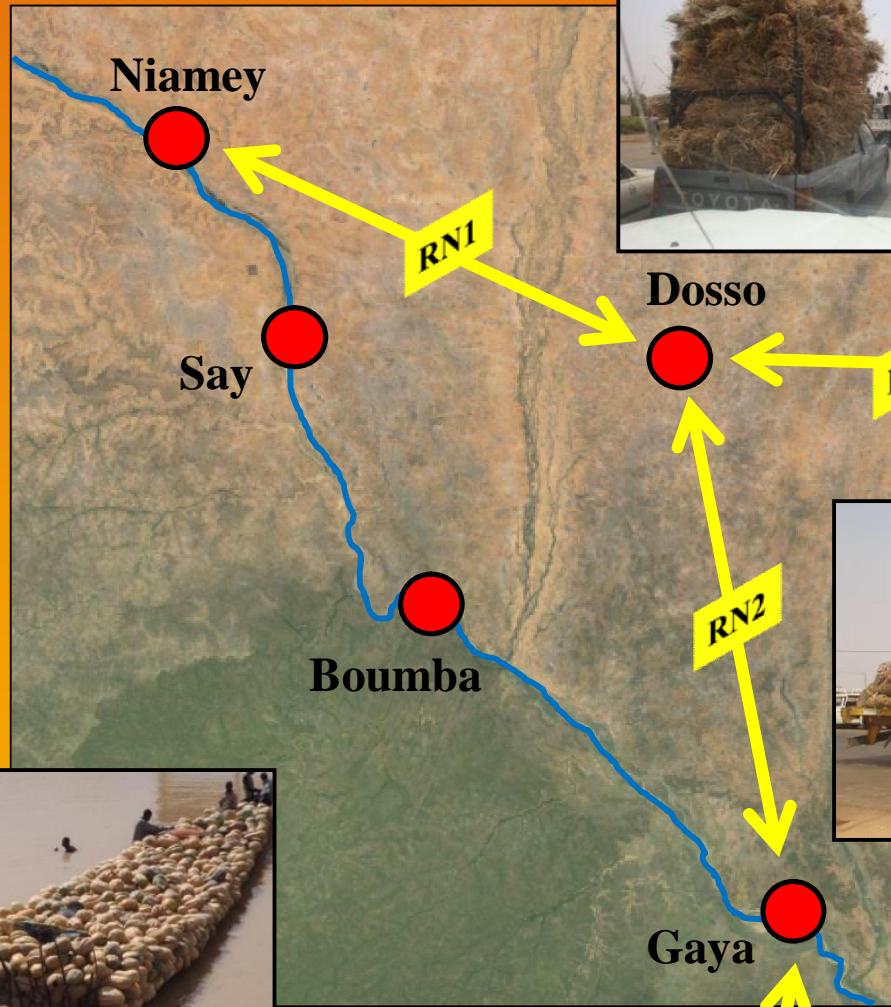# of the invasive black rat

Niamey

2.5 kms

Say

Dosso

Boumba

Gaya

50 kms

Highly structured populations

Very limited gene flow

**Some genetic signatures linking
Gaya, Dosso and Niamey**

Niamey

Say

Boumba

RN1

Dosso

RN1 — **Eastern Niger Nigeria**

RN2

Gaya

**Guinea Gulf harbours Benin, Togo í and the whole World**

Invasive black rats are imported directly in the core city (markets, industries, etc)

What does it tell us about in terms of zoonotic diseasesøcontrol?

To be efficient, public health strategies must take into account:

(1)Reservoir (and vector) species diversity,

(2)Their relative spatial distributions in relationships with the urban landscape,

(3)Processus at work (e.g. bioinvasions) that may deeply interfere with host dynamics, hence epidemiologic patterns.

What about rodent-borne pathogens in Niamey?

Toxoplasma gondii
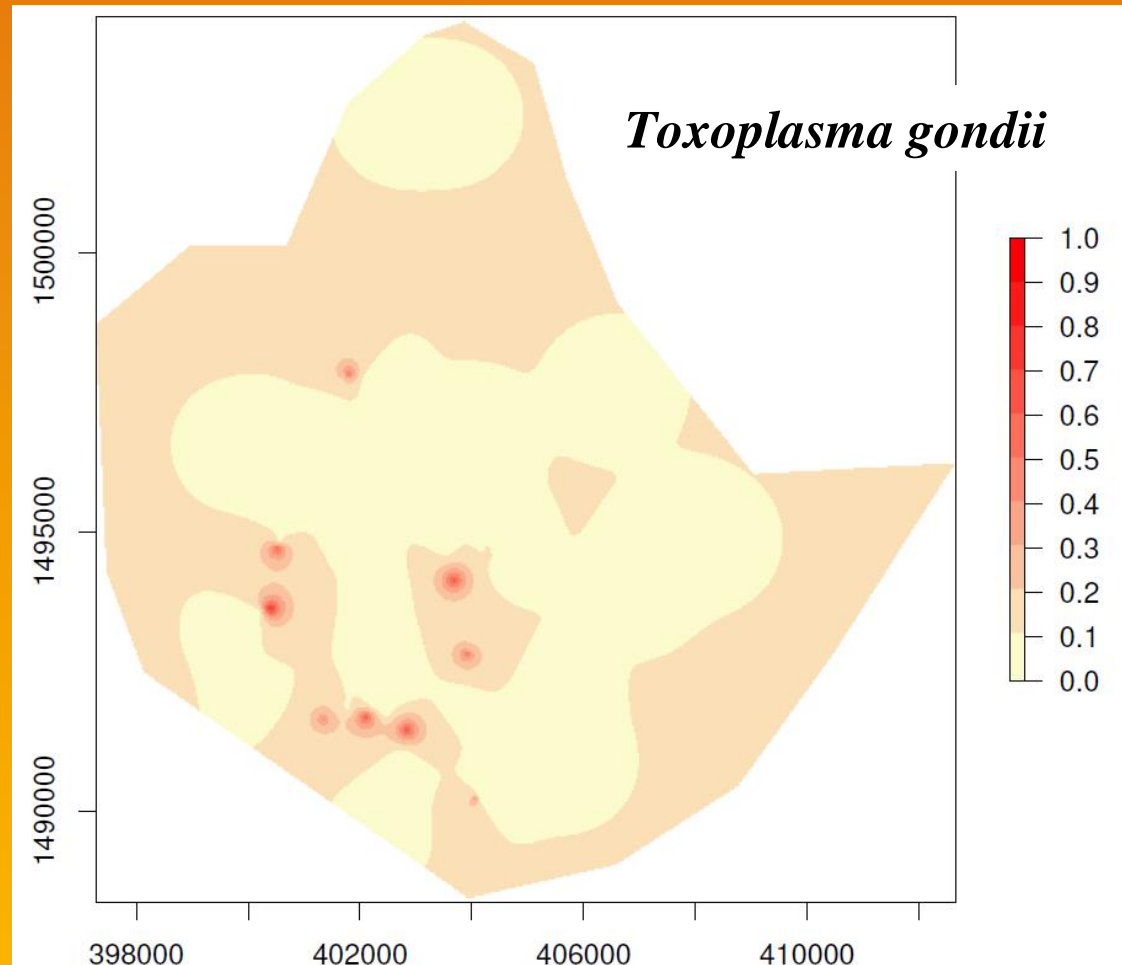
To be continuedí
(*Trypanosoma* spp., gastro-intestinal nematodes, *Leptospira* spp.?)

**Fofo
Nagodé
Thank you
Merci**