Application of very high spatial resolution remote sensing data for the characterization of risk areas for Rift Valley fever (RVF) in Senegal

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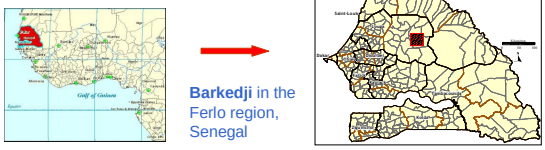
Objective : explore the potential of very high spatial resolution imagery to extract landscape indicators related to the risk of RVF transmission

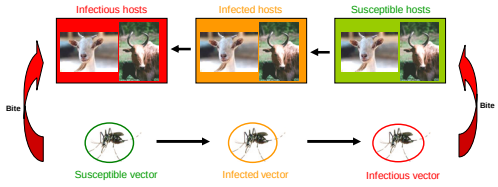
Study area



Barkedji in the Ferlo region, Senegal

Data

- ***Environnemental data***
  - Satellite Image : Quickbird sensor (2.4 m pixel resolution)
  - Field vegetation surveys (250 field data)
- ***Epidemiological data***
  - RVF serological incidence in 12 sheep flocks collected in 2003



Transmission cycle of Rift Valley fever

Rift Valley fever virus in Senegal

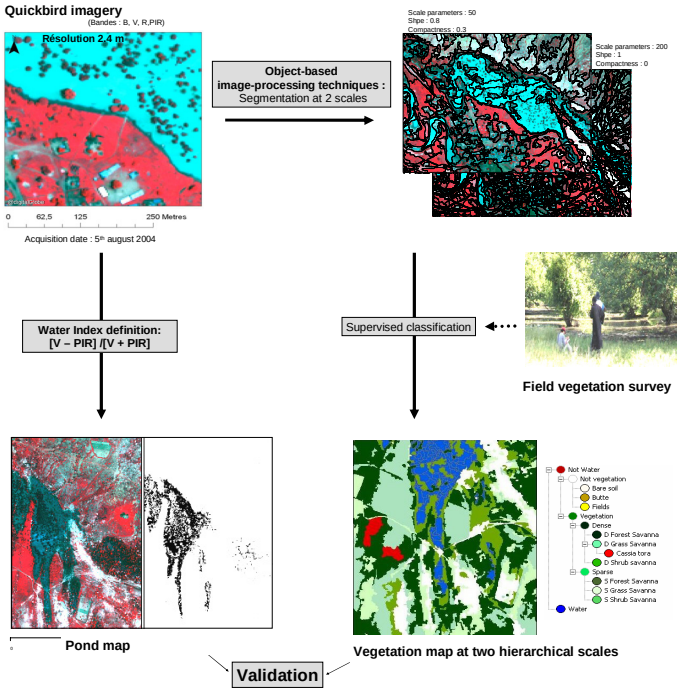
- *RVF is an **arbovirosis** caused by a **Phlebovirus** (*Bunyaviridae*)*
- **Main RVF vectors :** *Aedes* and *Culex* genera mosquitoes
- **Main hosts :** *ruminants* (sheep, goats and cattle)
- Human disease is often limited to a flu-like syndrome but severe cases are possible (retinitis, encephalitis, hemorrhagic fever)
- Temporary **ponds** are a favorable area for RVF transmission (Linthicum & al. 1985)

A landscape approach

- A study centered on the environment of ***ponds*** occupied by livestock and farmers (availability of surface water) and infested by mosquitoes
- The abundance of mosquitoes is linked to water body dynamics and their ecological characteristics

Extraction of landscape indices favourable for RVF vectors from Quickbird imagery

1) Mapping biotopes favourable to mosquitoes



2) Extraction of 3 landscape indexes for each pond

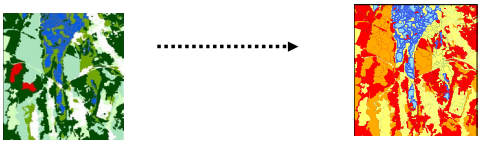
1) *Landscape Closure Index*

based on the hypothesis: the denser the vegetation, the higher the probability of mosquito presence

LCI =% Closed vegetation / % Moderatly open and Open Vegetation

- calculated within 100, 500 and 1000 m radius buffers around the pond

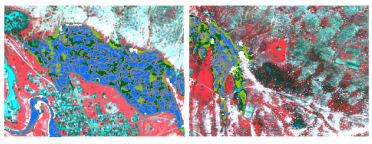
Dense Forest Savanna Dense Shrub Savanna	1: Closed Landscape
Dense Grass Savanna Cassia tora	2: Moderatly open Landscape
Sparse Savanna Butte Culture Bare soil	3: Open Landscape



2) *Water Vegetation Coverage Index*

Hypothesis : mosquito density is positively correlated with vegetation coverage of surface water

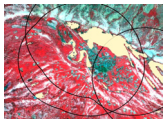
WVCI = Area of vegetation class / Total Area of the pond



3) *Pond Density Index*

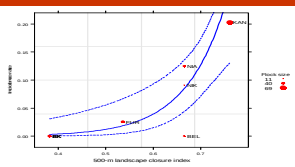
Hypothesis (Chevalier et al., 2005) : the higher the density of small ponds, the higher the occurrence of RVF.

PDI = [1/Surface of the pond 1 + …. + 1/ Surface of the pond i] within a radius of 1000m



Statistical analysis to identify landscape indices linked to the RVF incidence

- **Method :** We used a mixed-effect logistic regression model to test whether RVF serological incidence was explained by the landscape indices (fixed effects in the model).
- **Results :** *The **500-m landscape closure index*** was positively correlated with ***higher serological incidence* (*p < 0.05*)**.



Conclusion and perspectives

- The very high spatial resolution of Quickbird image was well suited to map mosquitoes breeding sites and biotopes possibly related to RVF-transmission risk. The statistical analysis provided preliminary results showing that the landscape closure might be associated with RVF-transmission risk.
- These results highlight the potential of high resolution remote sensing data to characterize the landscape structure at a fine scale. Further studies are needed to validate these results.
- The joint analysis of serological, virological and entomological data, together with farmers and livestock land-use data might provide further understanding of the epidemiological process. This information might be integrated in an agent-based model to represent the transmission of RVF and test surveillance and control measures.

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Reference :
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Linthicum K.J, Davies F.G, Kairo A., Bailey C.L, Hyg J., 1985. Rift Valley fever virus (family Bunyaviridae, genus Phlebovirus). Isolations from diptera collected during an inter-epizootic period in Kenya. *Journal of Hygiene* 95 (1), pp. 197-209

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