Deforestation, new migration pathways and outbreaks of the Red locust *Nomadacris septemfasciata* in the Sofia river basin (Madagascar)

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Nomadacris septemfasciata (Serville, 1838)
Orthoptera : Acrididae, Cyrtacanthacridinae
Sofia river Basin 50 000 km²

Background: Guillaumet et al. 1997
Red locust distribution in Madagascar
For the first time, gregarious populations in Sofia Area in 2003

Gregarisation threshold between 5 000 & 10 000 imagos /ha

**Solitarious**, Isolated and inoffensive for the crops

**Gregarious**, Grouped and devastating
To gregarise

Increase, multiplication and concentration of locust numbers,

Red locust needs 3 conditions:

- Good breeding rate,
- Low mortality,
- Concentration by efficient migrations
Outbreak Area

Gregarisation occurs in specified areas:
- Geographically delimited,
- Share *seasonal ecological complementarities conditions*, for the survival of the solitary locust every year,
- Migration pathways providing connectivity between ecological complementary areas
- And some years, with particular *eco-meteorological conditions*, locust can gather, multiply and exceed its gregarisation threshold.
For the first time in Madagascar, the Red locust reached gregarious phase between 1999 and 2003 in the Sofia area.

• Are some ecologic transformation, as deforestation, responsible of this new phenomenon?

• How did the *connectivity* change between Diapause and Reproduction areas?

• Does Sofia area become an Outbreak Area for the Red locust?
Methodology

• What are the ecological parameters to delimit the red locust migration pathways?

• How to map them?

• Diachronic study using remote sensing data to evaluate the evolution of the connectivity between Reproduction and Diapause areas.
Ecological parameters for locust migration

Considering that:

- Solitary Red locust migrate at twilight, from 6 pm to 11 pm
- Forest is an hostile habitat to the locust.
- Optomotor reaction for the migration: locust follows the white patches distributed within black areas.

=> Deforestation corridors may show the way
Ecological parameters for locust migration

Three main factors turn the locust migrations:

- Orography,
- Hydrography,
- Deforestation corridors: the only one may change over time.
Methodology

Selection of SPOT data (1&4)
- Resolution of 20 meters
- 3 or 4 spectral bands (G, R, NIR, MIR).
Data processing

Georeferencing:
• Reference image: 1986 registered with GPS points

• Image 2004 : registered with reference image
Data processing

The **post-classification** comparison method was applied for Land-cover change detection:

- Robust even if images does not match perfectly
- Needs 2 separate classifications (1986 et 2004)
- Change-detection accuracy depends on the accuracy of the 2 classifications
Land-cover classification

Supervised classifications using:

- GPS point for 2004,
- Photo-interpretation for 1986 (any field data available).

4 classes of Plant Community

<table>
<thead>
<tr>
<th></th>
<th><strong>Forest</strong>: dry forest, gallery forest</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td><strong>Mixed</strong>: secondary forest, fallow</td>
</tr>
<tr>
<td>3</td>
<td><strong>Grassy</strong>: savannas, meadows, steppes, crops</td>
</tr>
<tr>
<td>4</td>
<td><strong>Non Attractive</strong>: roads, water, urban habitat</td>
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</tbody>
</table>
Cost-distance

Cost-distance method to model the migration pathways:

- High cost for barriers
- Low cost for favourable environment

<table>
<thead>
<tr>
<th>Plant Community</th>
<th>Migration Cost</th>
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</thead>
<tbody>
<tr>
<td>Forest</td>
<td>20</td>
</tr>
<tr>
<td>Mixed</td>
<td>5</td>
</tr>
<tr>
<td>Grassy</td>
<td>1</td>
</tr>
<tr>
<td>Non Attractive</td>
<td>1</td>
</tr>
<tr>
<td>Slopes (&gt; 30°): using MNT (90m)</td>
<td>1000</td>
</tr>
</tbody>
</table>
Results, classification

Evolution of Plant communities (total surface)
Results, classification

Evolution of Plant communities (mean surface)

- Forest
- Mixed
- Grassy
- NA

Surface (m²):
- 1986
- 2004
Results

Evolution of migrations pathways
Conclusion (1)

- New migrations pathways due to deforestation
- Better connectivity between Diapause and Breeding areas
- Colonisation of new breeding areas now possible (west and south)

↗ ↗ the number of breeding areas colonisable => 
↗ ↗ the probability to find suitable breeding conditions each year => 
↗ of solitary locust numbers, and possibility to gregarise
Conclusion (2)

Conditions to fulfil for an outbreak area:

1. Seasonal ecological complementarities areas

2. Migration pathways between these areas.

Deforestation leads to a new outbreak area for a major crop pest in the North of Madagascar
ALTITUDE

DEFORESTATION
Regional evolution of the migration pathways