A Land Use/Land cover on the small Indian Ocean islands, an example of its use with the study of vector-borne diseases

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Introduction

Land use/land cover (LULC) data are key information to understand the relationships between humans and their environment. So, Many small islands are located in the southwestern Indian Ocean. These islands have their own environmental specificities and very fragmented landscapes. Generic LULC products developed from low and medium resolution satellite images are not suitable for studying these small territories.

When studying the geography and ecology of vector-borne diseases in small islands, high spatial resolution is also fundamental to measure the favorable or unfavorable conditions to the presence of the vectors and pathogens or to characterize the physical environmental of the people who have contracted a disease (Tran *et al.*, 2016). Also, the analysis of satellite imagery for use in the health field is limited by the technical difficulties inherent to remote sensing and access to remotely-sensed products.

To overcome this need, we realized a homogeneous high resolution land cover mapping of these small islands by analysing SPOT 5 satellite images. Our objective was to provide an easy accessible product with a common typology in order to allow comparative studies on several islands.

Material and methods

We used SPOT 5 satellite images (© CNES, Distribution Airbus Defense and Space) acquired between July 2013 and July 2014. The SPOT5 images used are a pair of images for each island with a panchromatic image at 2.5m resolution and a multispectral image with 4 channels (green, red, PRI and MIR) at 10m resolution.

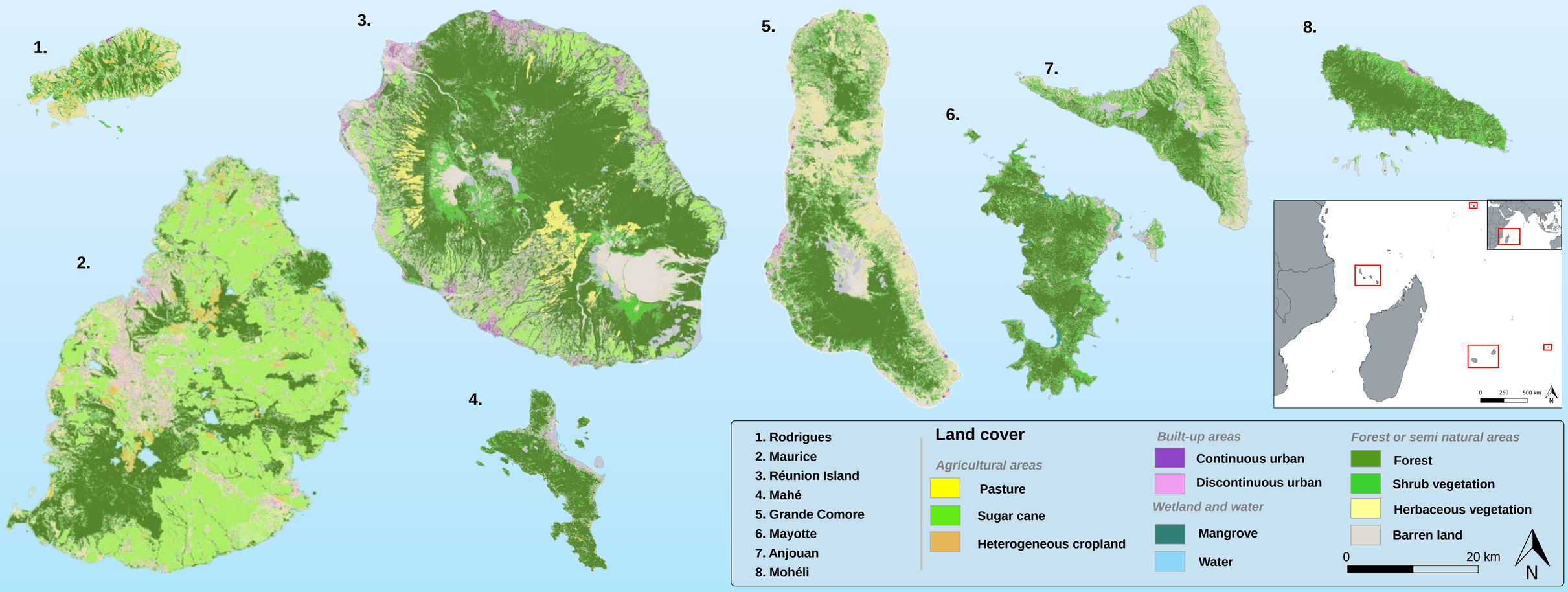
All additional vector data come from the OSM database. These are the main roads (key=highway; values=primary; secondary; tertiary; residential) and agricultural zoning (landuse=farmland). On these agricultural areas, additional tags are used when it comes to sugar cane (crop=sugarcane) which is a dominant crop on the two largest islands studied, Réunion Island and Mauritius.

The classification algorithm is a hierarchical object-based image analysis method, implemented in eCognition® software. Each object is described by attributes related to its reflectance, texture and geometry. Our hierarchical classification process is organized into two levels. A first level of segmentation with the objective of delineating agricultural and natural objects and a second level of segmentation with a smaller scale factor to extract urban areas, isolated buildings and main roads.

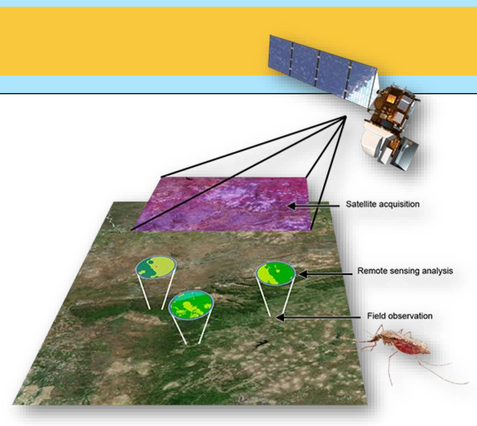
All the methodology is described in a paper in the Data journal (Revillion et al., 2019).

Classification results : Land cover and webmapping interface

We classified the LULC of these tropical islands into 11 major classes. Helped by a good knowledge of the field the classification reached a good general accuracy with a kappa of 0.85. This high resolution land cover is available on a web portal (**http://homisland.seas-oi.org/**) to ensure a wider distribution to researchers and thematicians using land cover information.



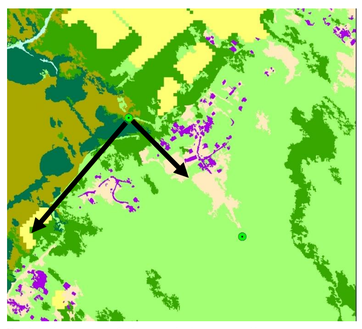
Applications in health research



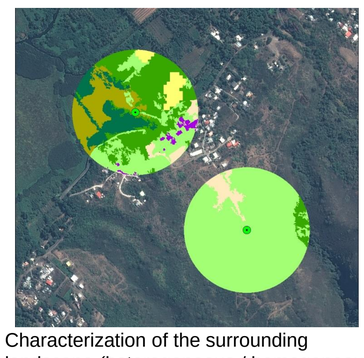
Land cover analysis provides very useful information for characterizing the environment of infectious diseases, which may be the habitat of vector species (such as mosquitoes, rodents) or the place of exposure to a disease. Studies can be based on animal samples precisely localized with a GPS, or on the location of people by their address.

For such analysis, we use the land cover map to calculate landscape indicators (or landscape metrics). The simplest are the minimum distances between each animal and each land cover class. Despite their simplicity, they provide valuable information when it comes to interpreting, for proximity of a species to humans or to wetlands.

The analysis can also define the immediate environment of each animal within a determined radius (a buffer zone around the capture points). Each landscape element within this radius is called a patch, and the calculations focus on their surface areas, contours and shapes. The nature of the landscape (built-up, forest, agricultural, etc.), its consistency or diversity, its fragmentation and the structure of its elements can be defined from this. One metric commonly used to describe landscape fragmentation is edge density, which is calculated by measuring the length of the contours in all the patches within a buffer zone and dividing this by the surface area.



Calculation of the minimum distances from one animal to each land cover class

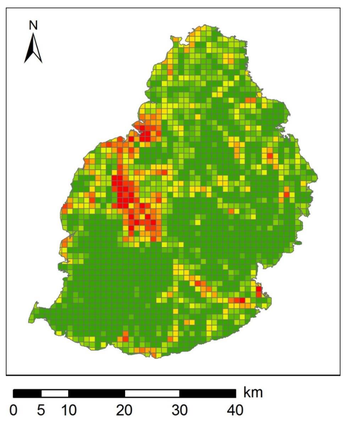


Characterization of the surrounding landscape (heterogeneous / homogeneous)

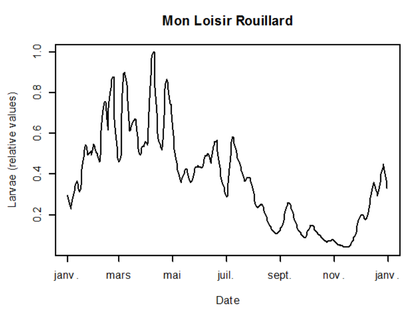
Modelling *Aedes albopictus* mosquito population dynamics in Mauritius

The 'Tiger' mosquito, *Aedes albopictus,* is a vector of viruses responsible for Chikungunya and dengue fever.

A model of mosquito population dynamics was applied to Mauritius, using as input data land cover combined with elevation, and daily temperature and rainfall data. Land cover information is used to estimate the environmental suitability for *Aedes albopictus* breeding sites (from built-up areas classes) for each 1km² square cell.

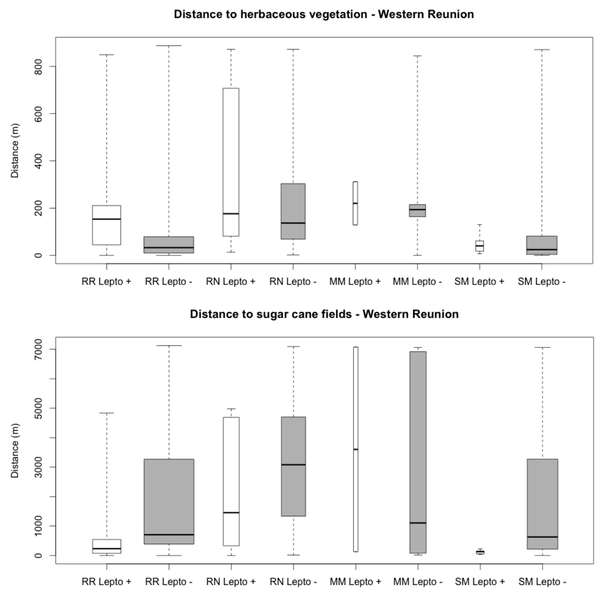


For each cell, the model outputs are: an estimation of the number of aquatic (eggs, larvae, pupae) and adult mosquito stages.



This simulation tool is adapted for supporting decision-making in the surveillance and control of mosquito-borne diseases.

Use of landscape metrics to compare rodent populations in Reunion Island



Two landscape metrics for comparing positive and negative rodents to leptospirosis, with 4 species (*Rattus rattus, Rattus norvegicus, Mus musculus and Suncus murinus*), in Reunion island

Acknowledgements

The authors would like to thank :

The SEAS-OI platform for the distribution of SPOT5 images;

The 3Liz (3liz.com) company for its remarkable free and opensource webmapping tool, lizmap for QGIS.

Funding

- LeptOI project (FEDER POCT 31569);
- ISSE-Mayotte project (French Ministry of Outremer, MOM 2012);
- IRD for the funding of a PhD thesis (ARTS) in the Comoros;
- TROI project (FEDER InterReg V).

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