A free high resolution 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

The southwest of the Indian Ocean comprises numerous islands of less than 3000 sq km (including the Comoros Archipelago, the Seychelles Archipelago, the Mascarene Islands). These small island territories have very fragmented and diversified environments. Land cover and land-use mapping of such environments requires satellite images with high spatial resolution. Unfortunately, the land use products available so far were only at low resolutions (usually from 4 kilometers to 250 meters).

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.

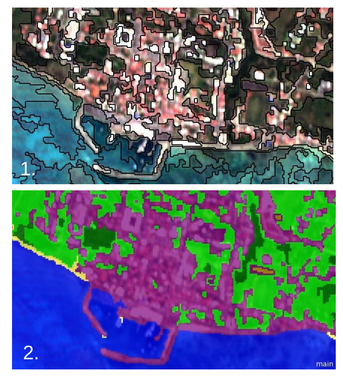
To overcome this need, we realized a homogeneous high resolution land cover mapping of these small islands by analysing SPOT 5 satellite images. Our objective was to provide an easy accessible product with a common typology in order to allow comparative studies on several islands.

Material and methods

SEAS-OI Station (http://www.seas-oi.org/) provided SPOT 5 satellite images (© CNES, Distribution Airbus Defence and Space) acquired between July 2013 and July 2014.

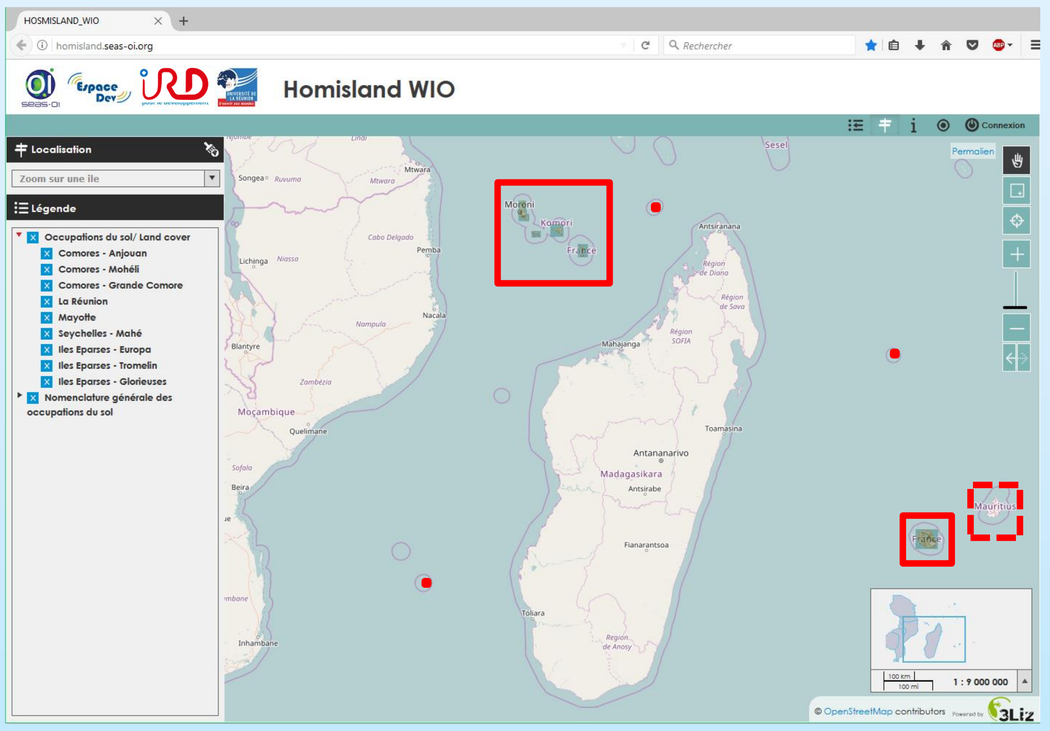
We used a hierarchical object-based image analysis method, implemented in eCognition® software. The object-oriented approach is divided into two main stages, segmentation and classification. The segmentation consists in grouping the pixels with their neighbors to create objects larger and bigger by respecting thresholds uniformity. These thresholds are calculated according to several parameters such as spectral value and shape (Blaschke, 2010).

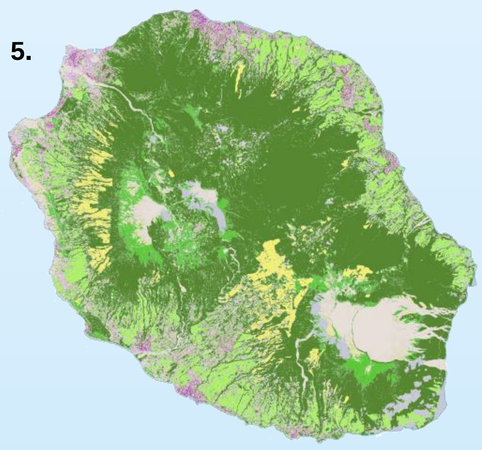
The hierarchical classification allows to group the objects by the formulation of rules that can be combined, resulting from the observation and the knowledge of the operator. Each object is described by attributes related to its reflectance, texture and geometry.



The two stages of object-based image analysis 1. segmentation of the satellite image 2. hierarchical classification

Classification results : Land cover and webmapping interface





We classified the land cover / land use of these tropical islands into 12 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.

1. Grande Comore
2. Mayotte
3. Mohéli
4. Anjouan
5. Reunion Island
6. Mahé

Land cover

Built-up areas
- Continuous urban
- Discontinuous urban

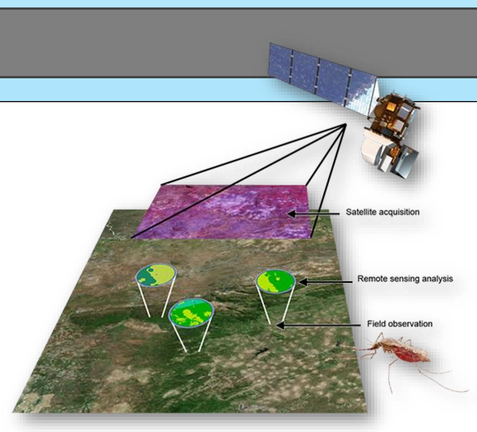
Forest or semi natural areas
- Forest
- Shrub vegetation
- Herbaceous vegetation
- Barren land

Agricultural areas
- Pasture
- Sugar cane
- Orchard
- Heterogeneous cropland

Wetland and water
- Mangrove
- Water

Land cover realized
Land cover in project
0 20 km
N

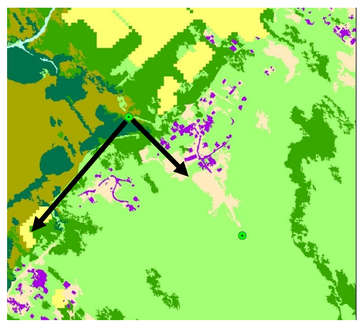
Applications in health research



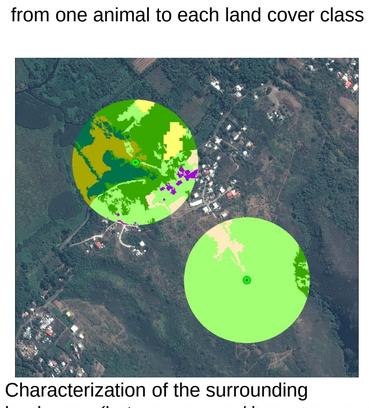
Land cover analysis provides very useful information for characterizing the environment of infectious diseases, which may be the habitat of vector species (such as mosquitoes, rodents) or the place of exposure to a disease. Studies can be based on animal samples precisely localized with a GPS, or on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

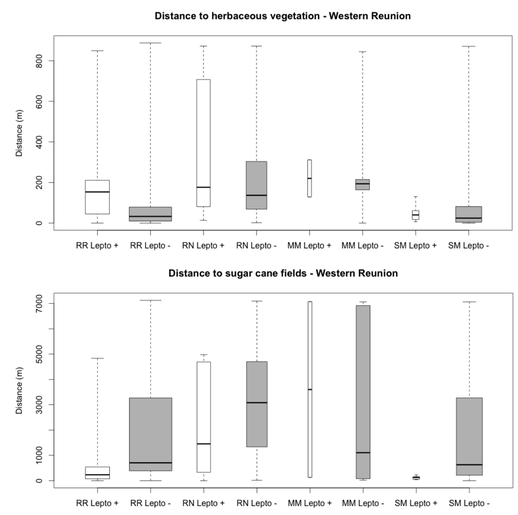


Calculation of the minimum distances from one animal to each land cover class

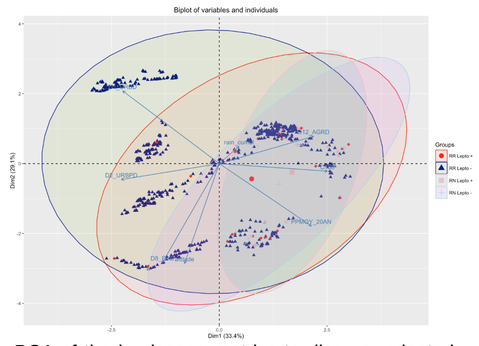


Characterization of the surrounding landscape (heterogeneous / homogeneous)

Example of the use of landscape metrics :



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



PCA of the landscape metrics to discern rodents by positivity and species (in Mahe, Seychelles)

Conclusion

This land cover has been used for several researches, including:

- malaria in the Comoros ;
- leptospirosis in rodents in La Réunion and Mahé Seychelles ;
- dengue cases in Reunion Island ;
- congenital disorders in Reunion Island.

Perspectives :

- Complete this land cover on other islands (Maurice, Rodrigues) ;
- Broaden the scope of users by increasing the access possibilities (for instance, by WMS) ;
- Update this land cover by using SPOT6 / 7 images. It will allow diachronic studies.

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References

Blaschke T., 2010. Object based image analysis for remote sensing. *ISPRS Journal of photogrammetry and remote sensing*, 65(1), 2-16

Révillion, C., Lagadec, E., Le Minter, G., Dessay, N., Guernier, V., Sand, A., ... & Herbreteau, V. (2015). Utilisation de la très haute résolution spatiale pour la caractérisation des habitats de rongeurs, vecteurs de zoonoses à la Réunion. *Revue Française de Photogrammétrie et de Télédétection*, (209), 65-71.

Tran A., Kassié D. & Herbreteau V. (2016). Applications of Remote Sensing to the Epidemiology of Infectious Diseases: Some Examples. In: Land Surface Remote Sensing: Environment and Risks (eds. Baghdadi N & Zribi M). Elsevier, pp. 295-315.

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