
# Airborne hyperspectral remote sensing for vegetation mapping in New Caledonia

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***Objectives*: Monitoring of the environment is of significant interest for New Caledonia as it is a biodiversity hotspot, as well as one of the greatest nickel reserve on the planet that is exploited. To adress that topic, a vegetation mapping method was developped to recognize plant communities from the mountain to the sea. It is based on HyMap airborne hyperspectral image analysis and support vector machine classification. That work was part of the CNRT-CARTHA project which aimed at developping methods for airborne hyperspectral mapping of the regolith and the environment of New Caledonia.**

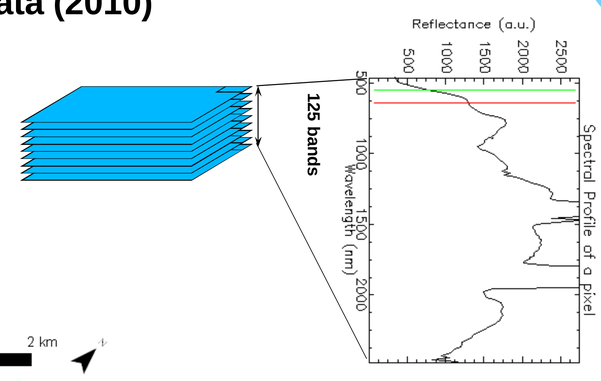
## Contexte

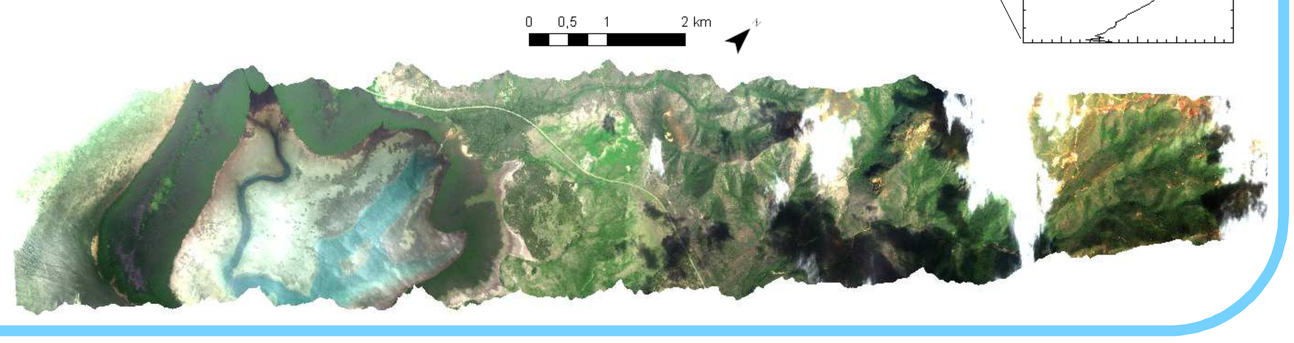
New Caledonia is a tropical island that has rose on the Norfolk ridge. The ground is rich in phytotoxic metal elements like chrome, cobalte, nickel. The vegetation growing there has adapted to that toxicity over years, leading to 74% of endemism over all the vegetation species present in New Caledonia. Mining may be occurring on a biodiversity hotspot that have to be preserved. Therefore, mapping of the plant communities is necessary at all stages of mining for a range of requirements including to satisfy governmental environment regulations, to provide a baseline of vegetation status and inventory and establish the priorities in vegetation preservation and routine monitoring of impact.


## HyMap Data (2010)

**First airborne hyperspectral dataset in NC**

- 25 flightlines
- Footprints: 2-3 x 5-20 km
- Pixel: 3.5 - 4.5 m
- Spectra: 125 bands ∈[450;2500] nm




## 1. Pre-processing

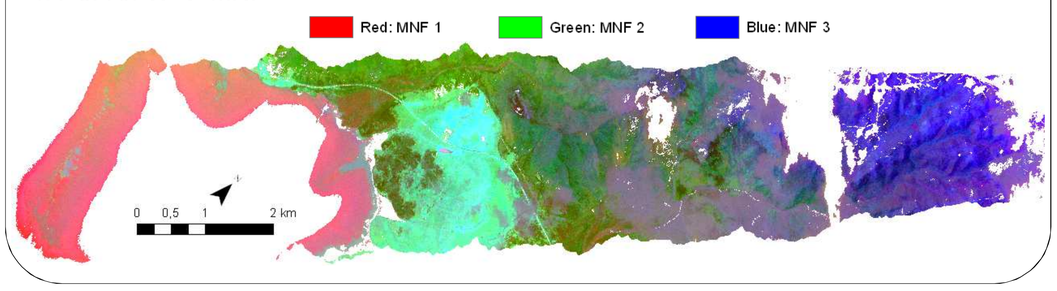
**Atmospheric correction:**
- ACWV and band shift estimates with Second Order Derivative Algorithm (CSIRO)
- MODTRAN 5

**Geocorrection:**
- HyVista algorithm
- 3rd order polynomial fit

**Masks:**
- Bare soil: NDVI < 0.3
- Water & shades: $R_{1650}$ < empiric value
- Clouds: $R_{450}$ > empiric value

## 2. Minimum Noise Fraction Transform

1. Spatial HF filter of the image: spatial noise
2. PCA of noise: $[\sigma^2]$ eig. val. & $[E_n]$ eig. vec.
3. Noise decorrelation & whitening: $[W]=[1/\sigma]*[E_n]*[Img-m(Img)]^T$
4. PCA of W → MNF




## 3. Classification method

**Support Vector Machine:**
- Non-linear mapping algorithm
- Efficient with small training dataset
- Kernel: radial basis function

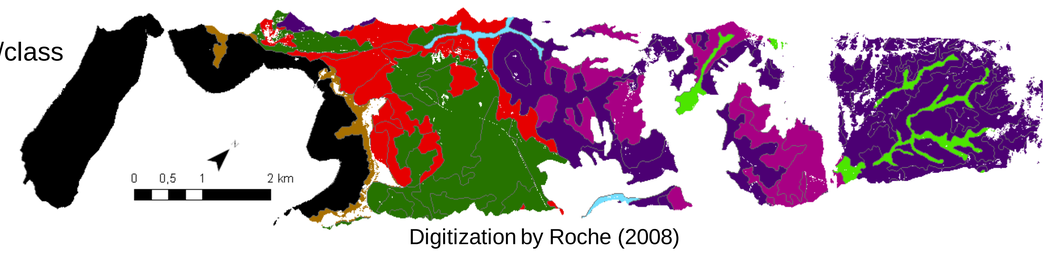
**Training & validation**:
- dataset: pixels randomly selected and equally distributed over classes
- targets: expert digitization
- method: 10-folds cross-validation

**Test**: whole map

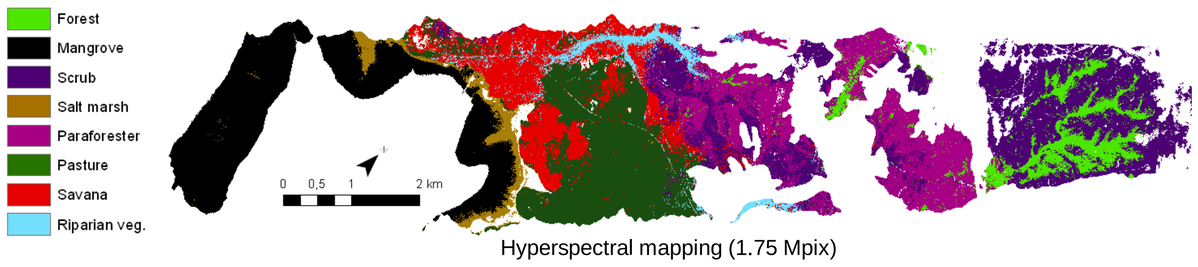
## General plant communities

Validation dataset: 16730 pix./class
Results:

| Train | Valid. | Test |
|---|---|---|
| 84.4% | 84.9% | 80.7% |




Digitization by Roche (2008)

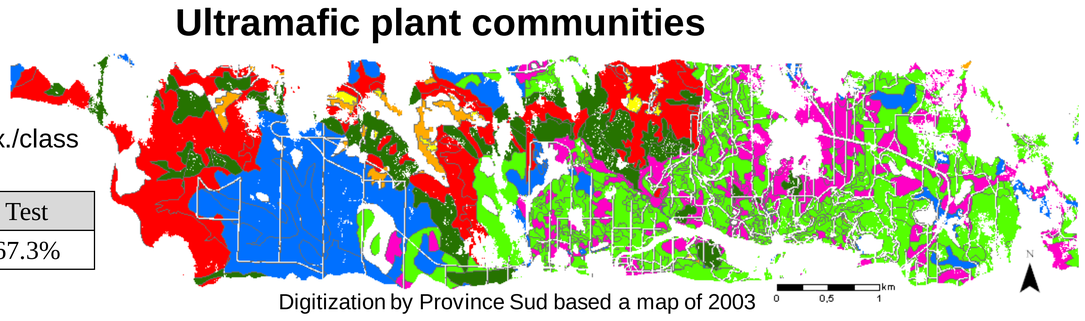



Hyperspectral mapping (1.75 Mpix)

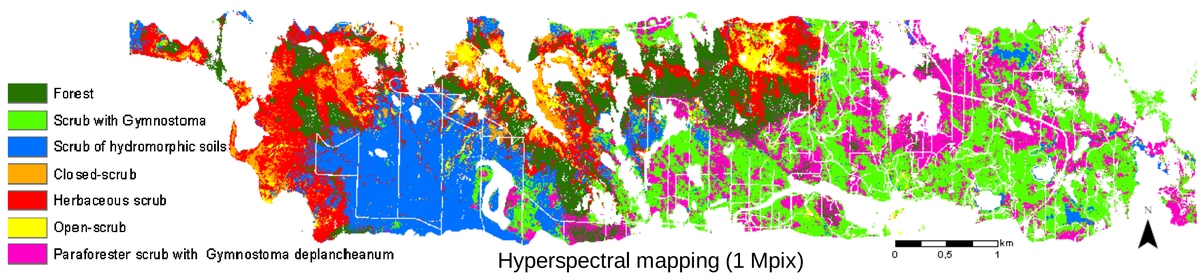
## Ultramafic plant communities

Validation dataset: 2000 pix./class
Results:

| Train | Valid. | Test |
|---|---|---|
| 71.8% | 69.3% | 67.3% |




Digitization by Province Sud based a map of 2003

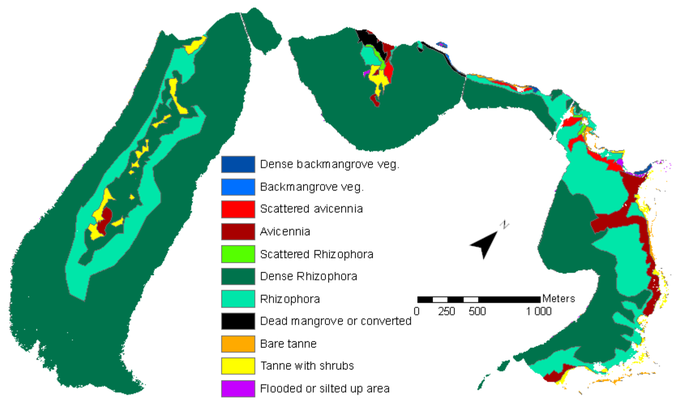



Hyperspectral mapping (1 Mpix)

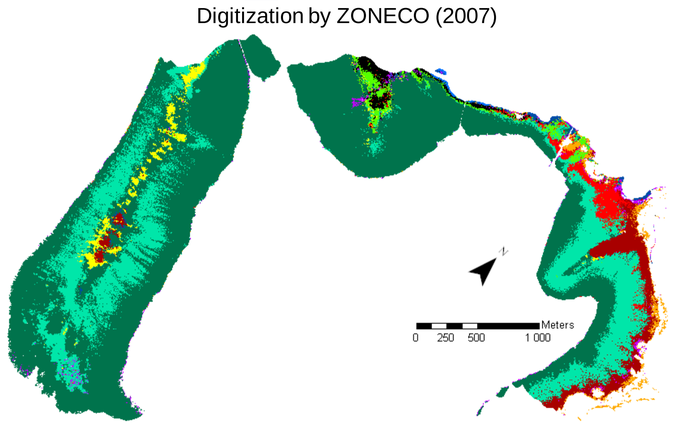
## Mangrove species-density

Validation dataset: 230 pix./class
Results:

| Train | Valid. | Test |
|---|---|---|
| 65.9 % | 63 % | 72.0% |




Digitization by ZONECO (2007)




Hyperspectral mapping (0.4 Mpix)

***Conclusion*: Mapping the vegetation thanks to airborne hyperspectral images was tested as prospective technic to evaluate its potential over the particular plant communities of New Caledonia. The mapping algorithm we developped was evaluated at three levels of complexity. The general plant communities are well recognised with a rate of 80%. The ultramafic plant communities are well discriminated with a rate of 67%. Finally the mangrove species and density were mapped with an accuracy of 72% compared to the mangrove digitization of the same area. Errors can be attributed to the classification result but also to the digitization as well as an evolution of the site between acquisitions. Future work will be dedicated to increase the classification accuracy and the number of classes. Data fusion of hyperspectral with other information (Lidar, DEM, …).**