APPLICATION OF REMOTE SENSING IN VEGETATION STUDIES AND HABITAT MANAGEMENT OF THE AZORES

Workshop "The use of sentinel data for supporting land and marine spatial planning and management – specificities of small oceanic islands"

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Ponta Delgada | Workshop ESA - NEREUS | 28 de setembro de 2015

Research Group, centered in the University of the Azores, wich focuses in Applyed Vegetation Ecology, with three investigation vectors:

1 – Descriptive research

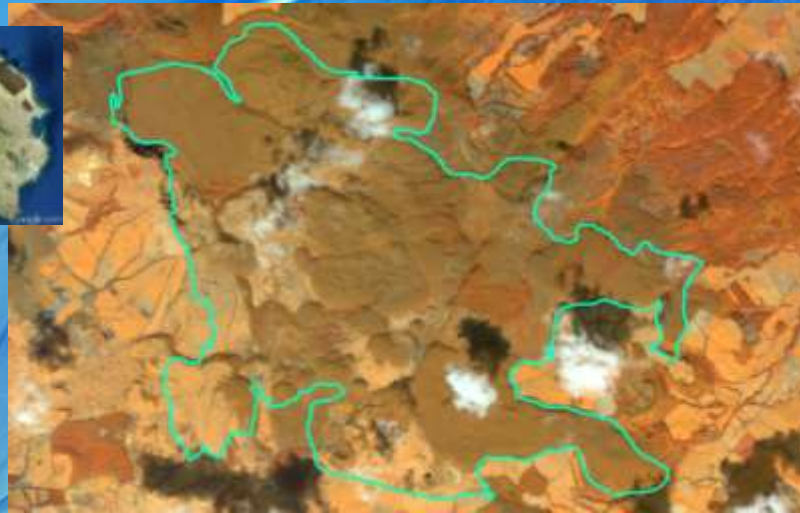2 – Analytical research

3 – Modelling and support to decision
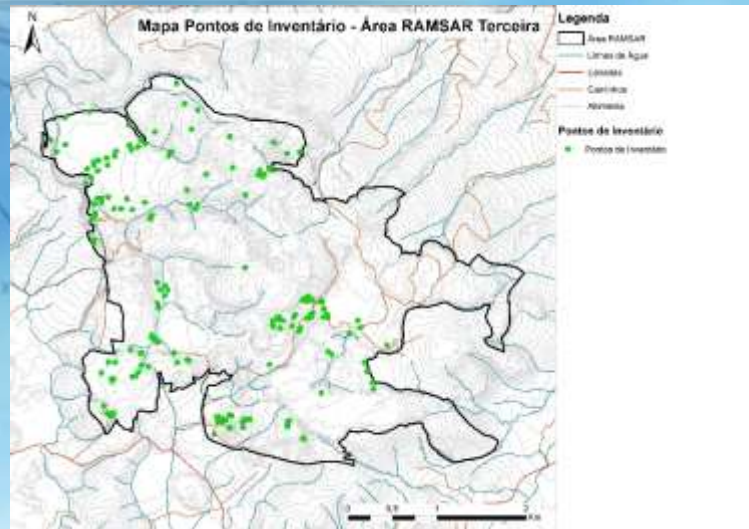
1 – Descriptive and analytical research

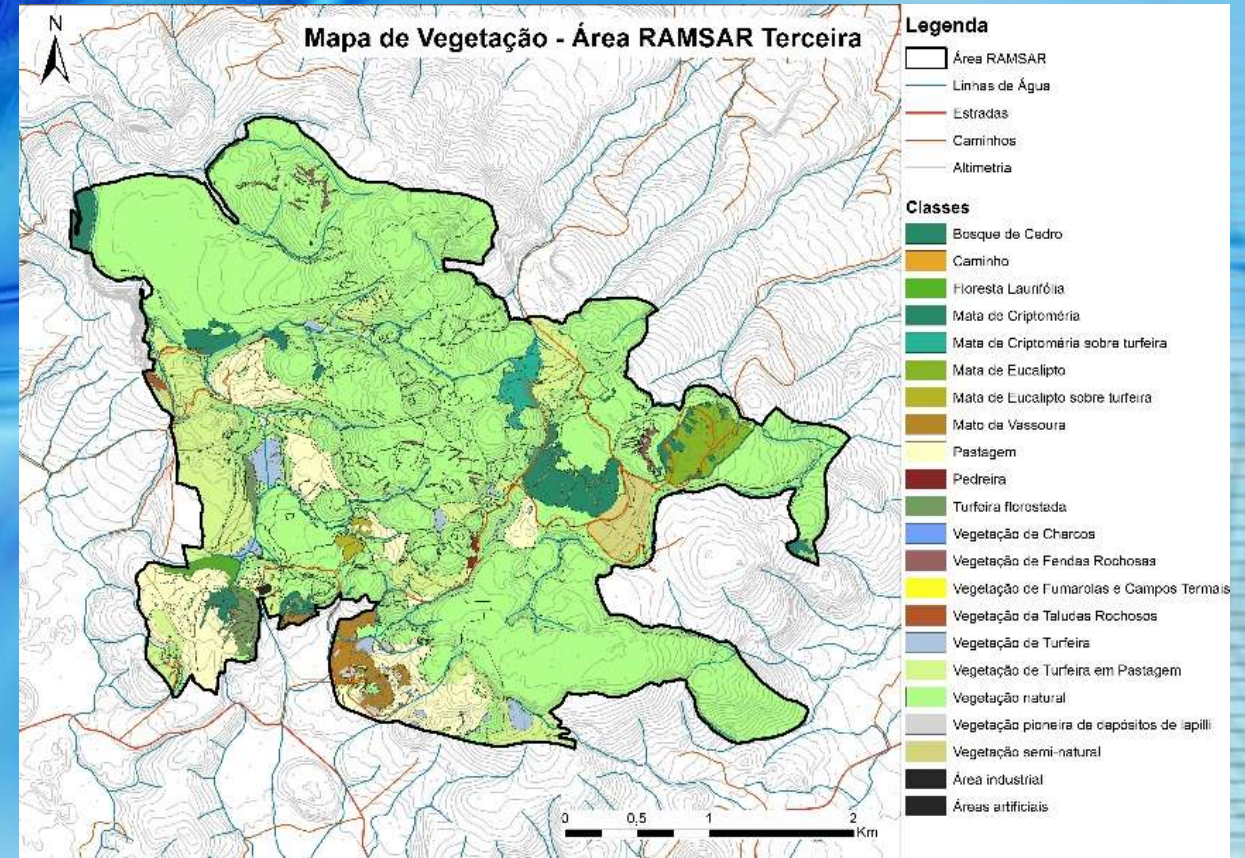# Field surveys and flora and habitats mapping
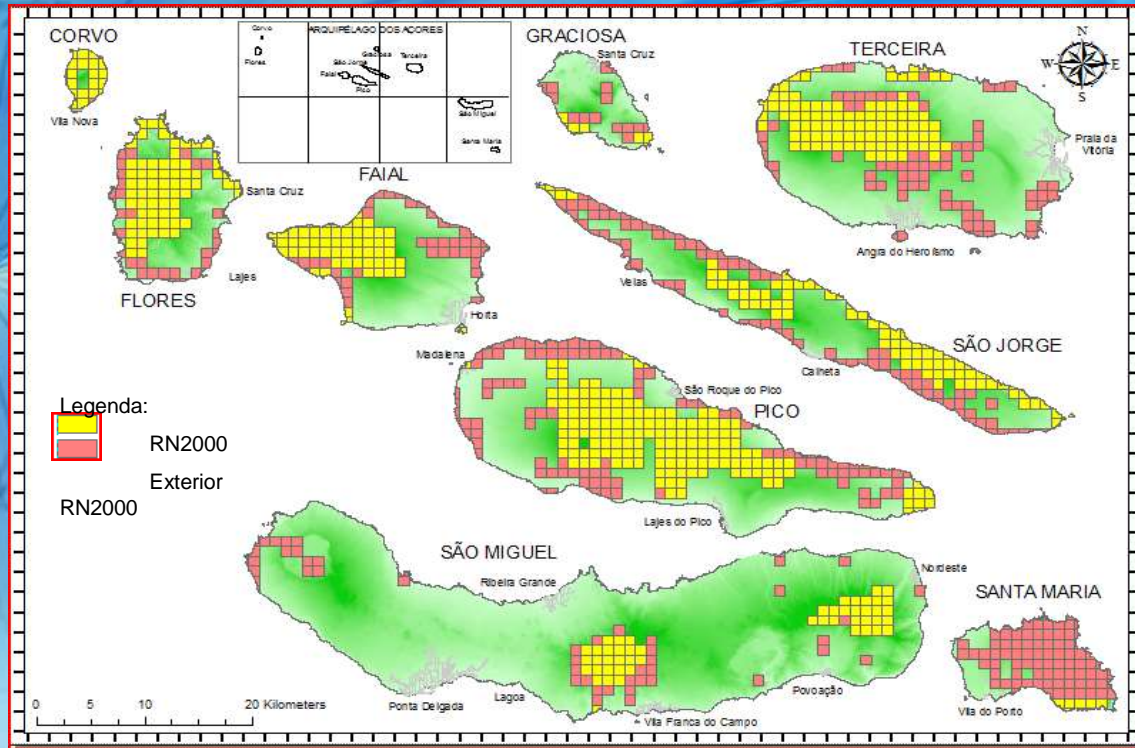
Field surveys of flora and habitats mapping:
Rapideye as a tool to help vegetation mapping (RAMSAR Area inTerceira Island)

RAMSAR Area in Rapideye

Survey points of Flora and vegetation
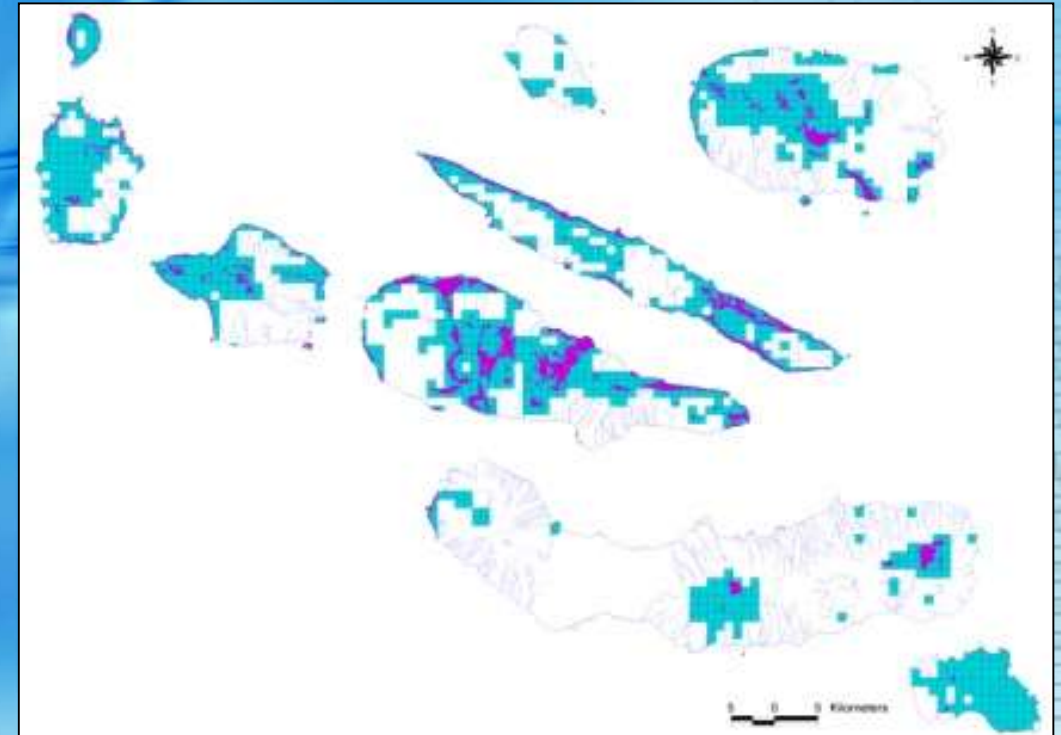

First mapping of the vegetation

- Rapideye imagery helps in the spectral differentiation of some major vegetation formations.

- Drone Aerial photo helps in vegetation formations that have punctual distribution.

(Rapideye - "Data provided by the European Space Agency")

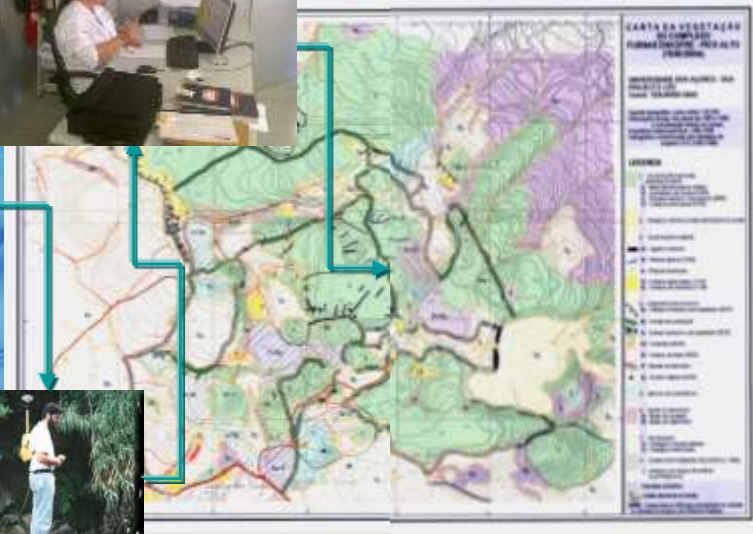# Natursa 2000: distribution patterns of species and habitats
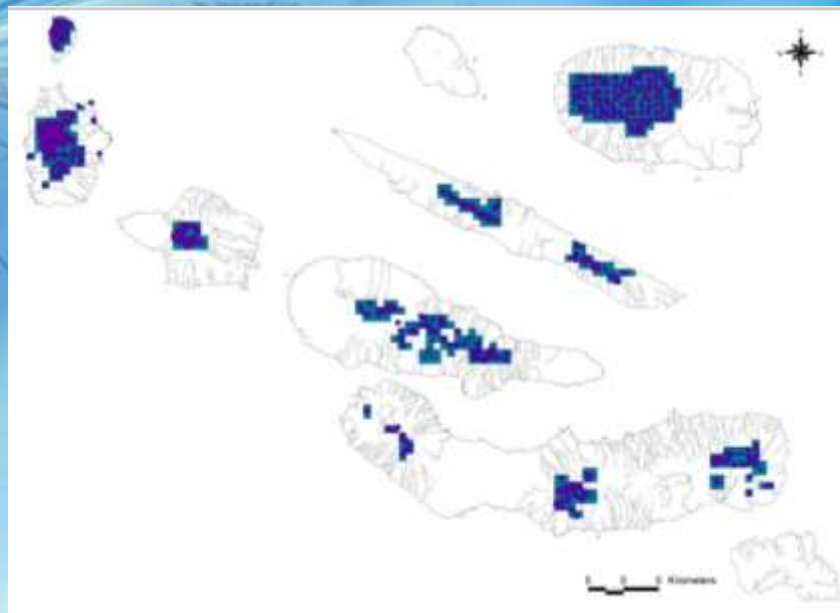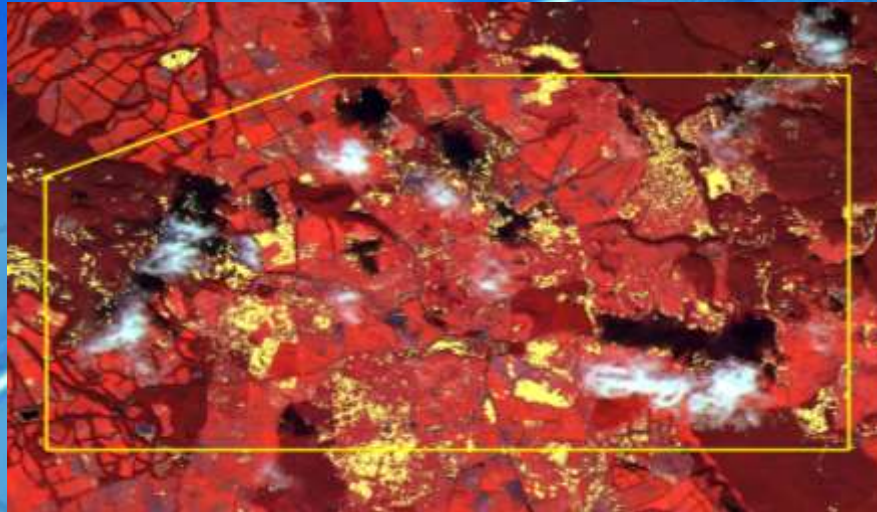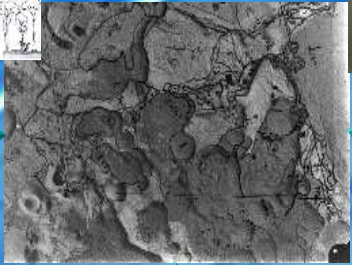

Sphagnum sp.

4050 - Matos macaronésicos

(Rapideye - "Data provided by the European Space Agency")

Analysis of distribution patterns of rare species and habitats
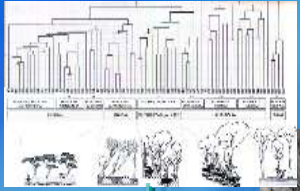
Field surveys are inserted in GIS database

Field surveys of rare plant species and habitat classification

Peat Bogs types and distribution at Terceira Island - GEVA
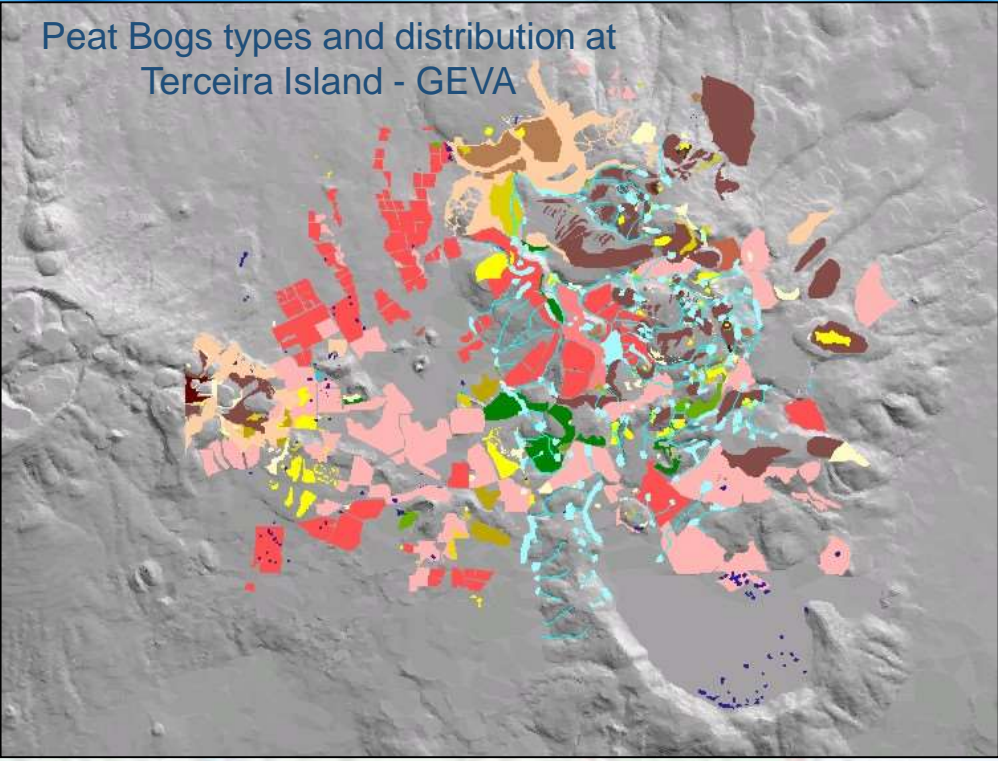
GIS allows the analysis of vegetation types and distribution patterns

2 – Modelling and support to decision
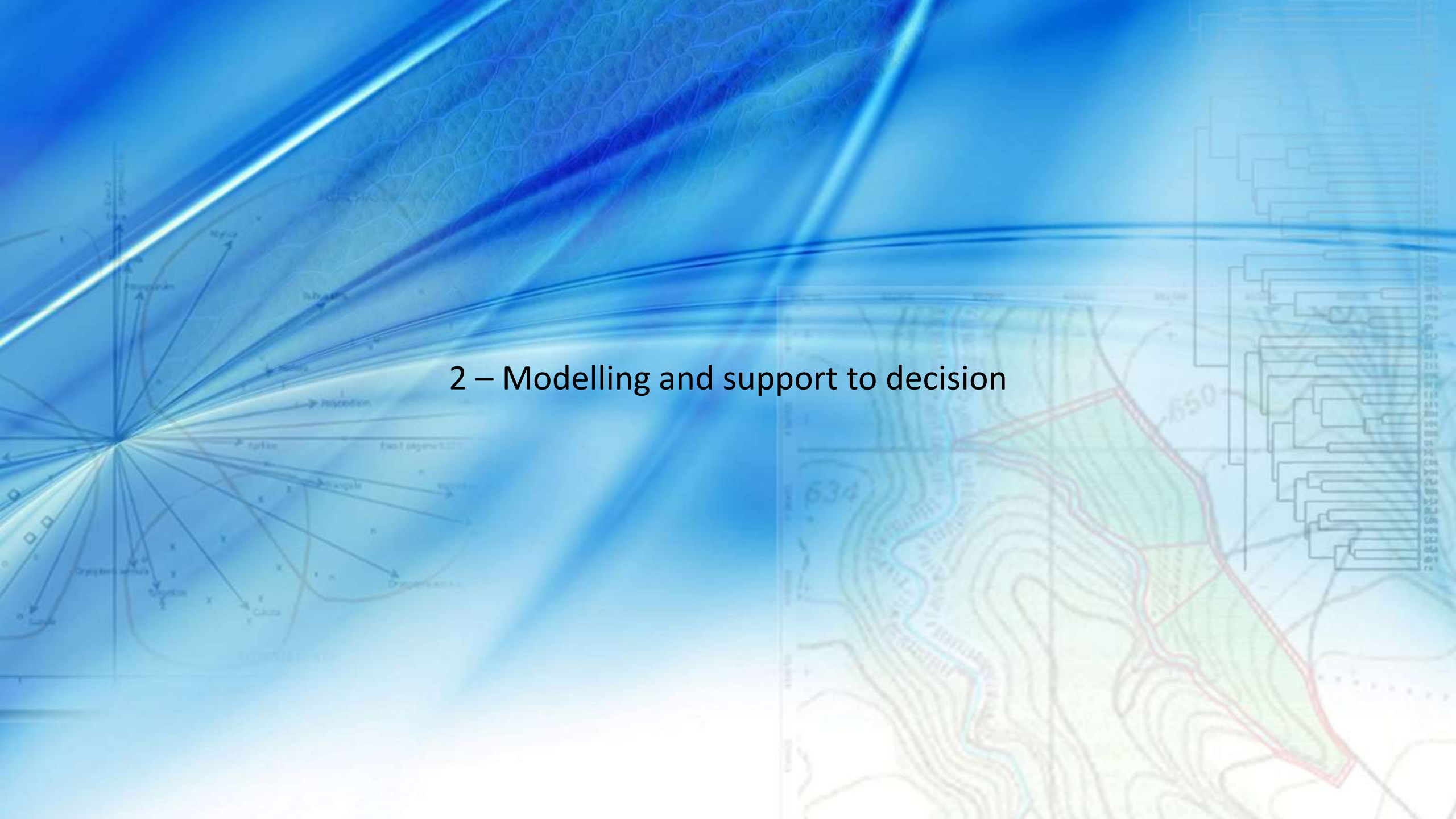
Model of potential distribution of natural Azorean
Forests – FORESTAÇOR © - for Pico da Vara

LIFE-SPEA Laurissilva
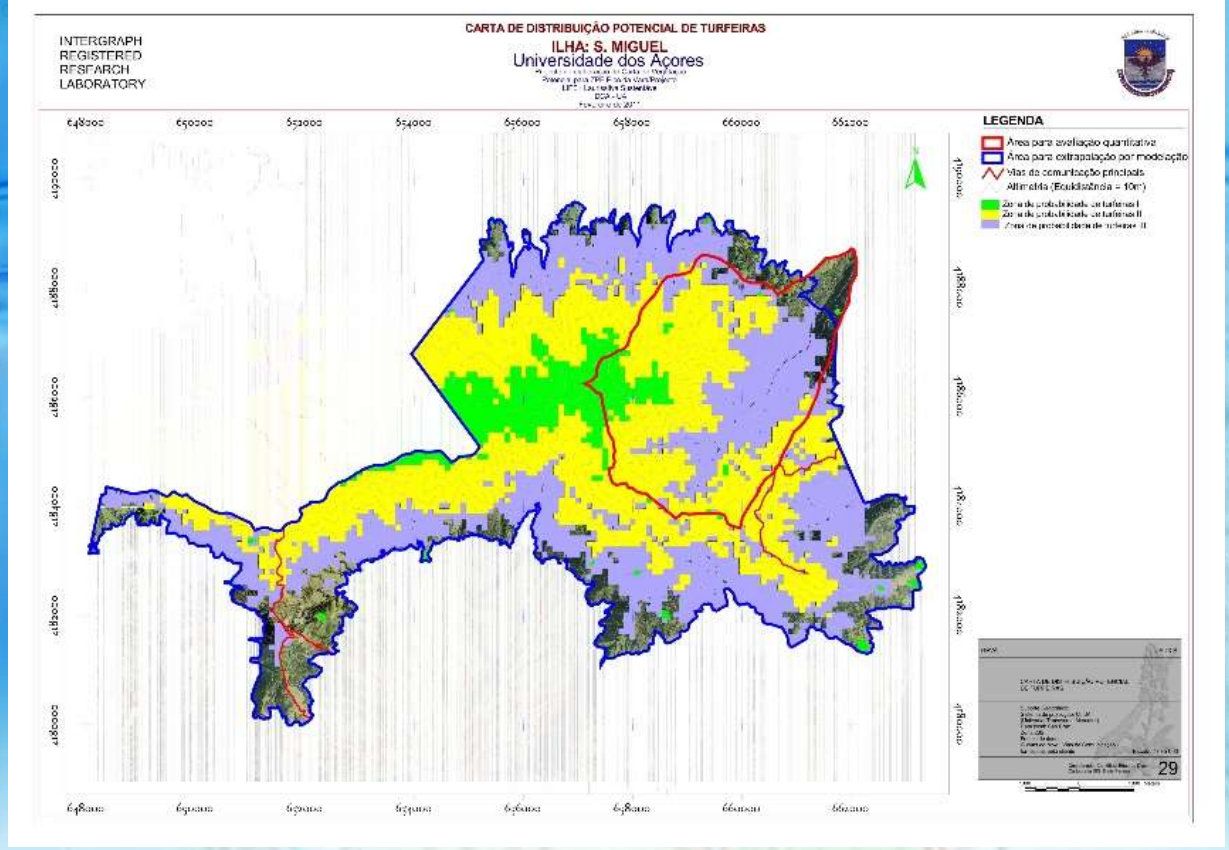
Model of potential distribution of peatlands, for
Pico da Vara

LIFE-SPEA Laurissilva

Modelation of Ecological Optimum for plants species
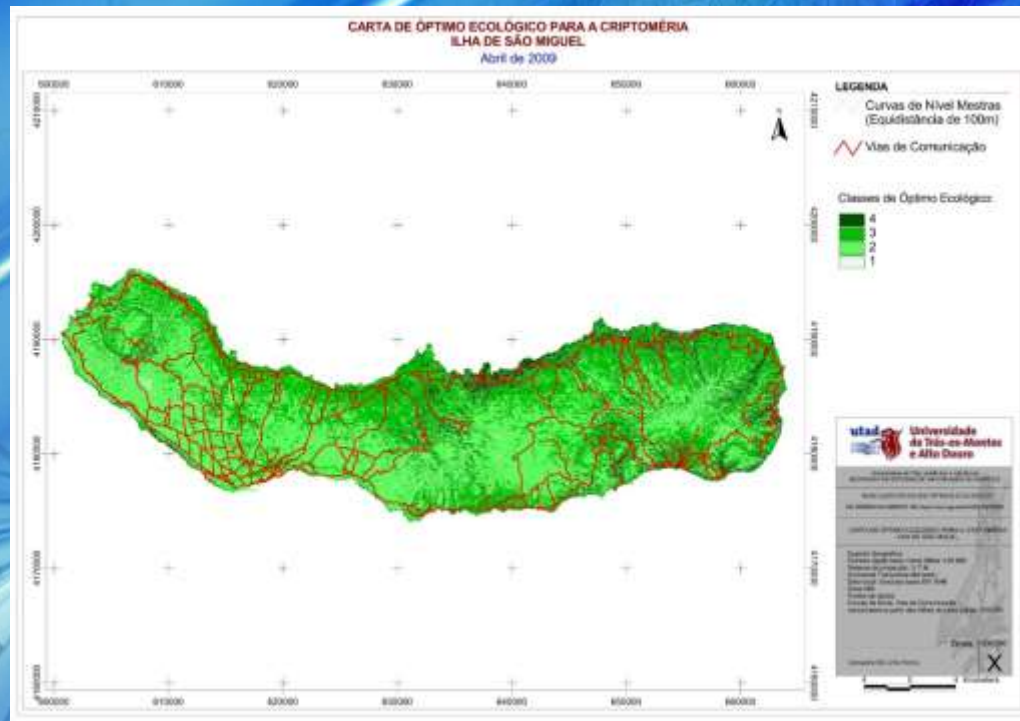
Ecological Optimum for *Cryptomeria japonica*
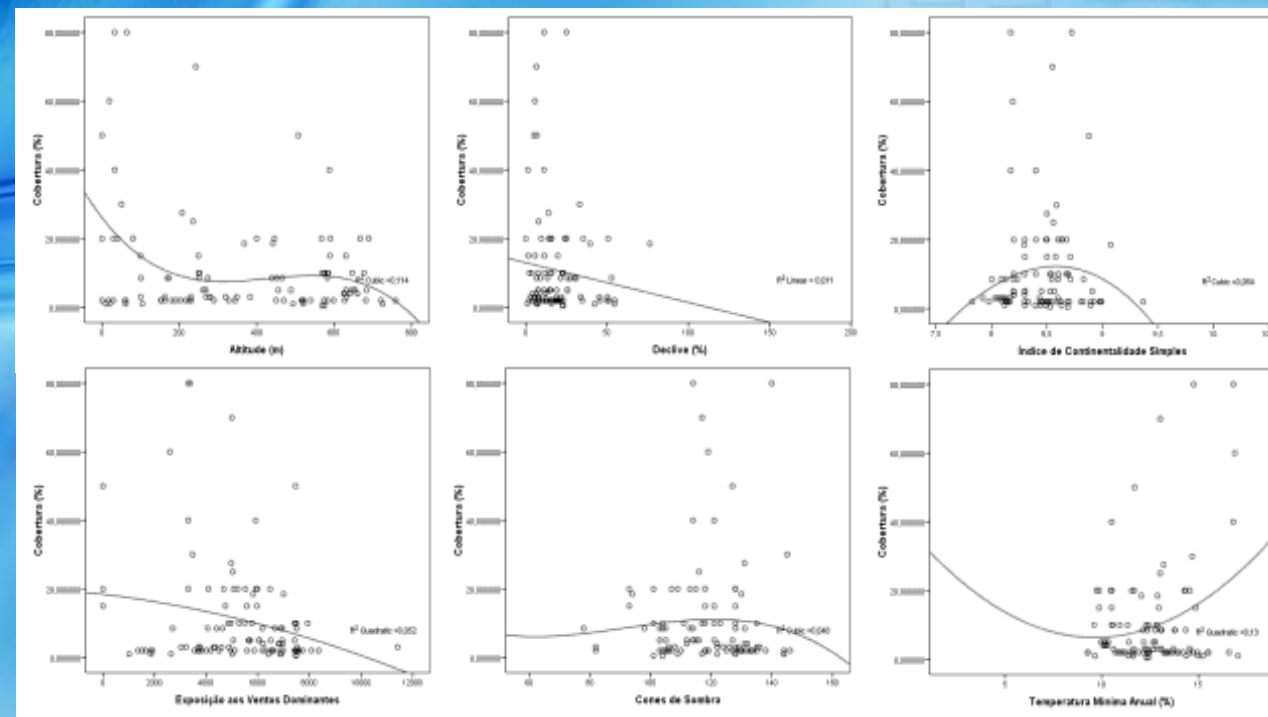
Ecological Optimum variables
for *Picconia azorica*

Spatial analysis of biodiversity for ecological corridors on protected areas

Ecological corridor
of Serreta

Ecological corridor
of central plateau
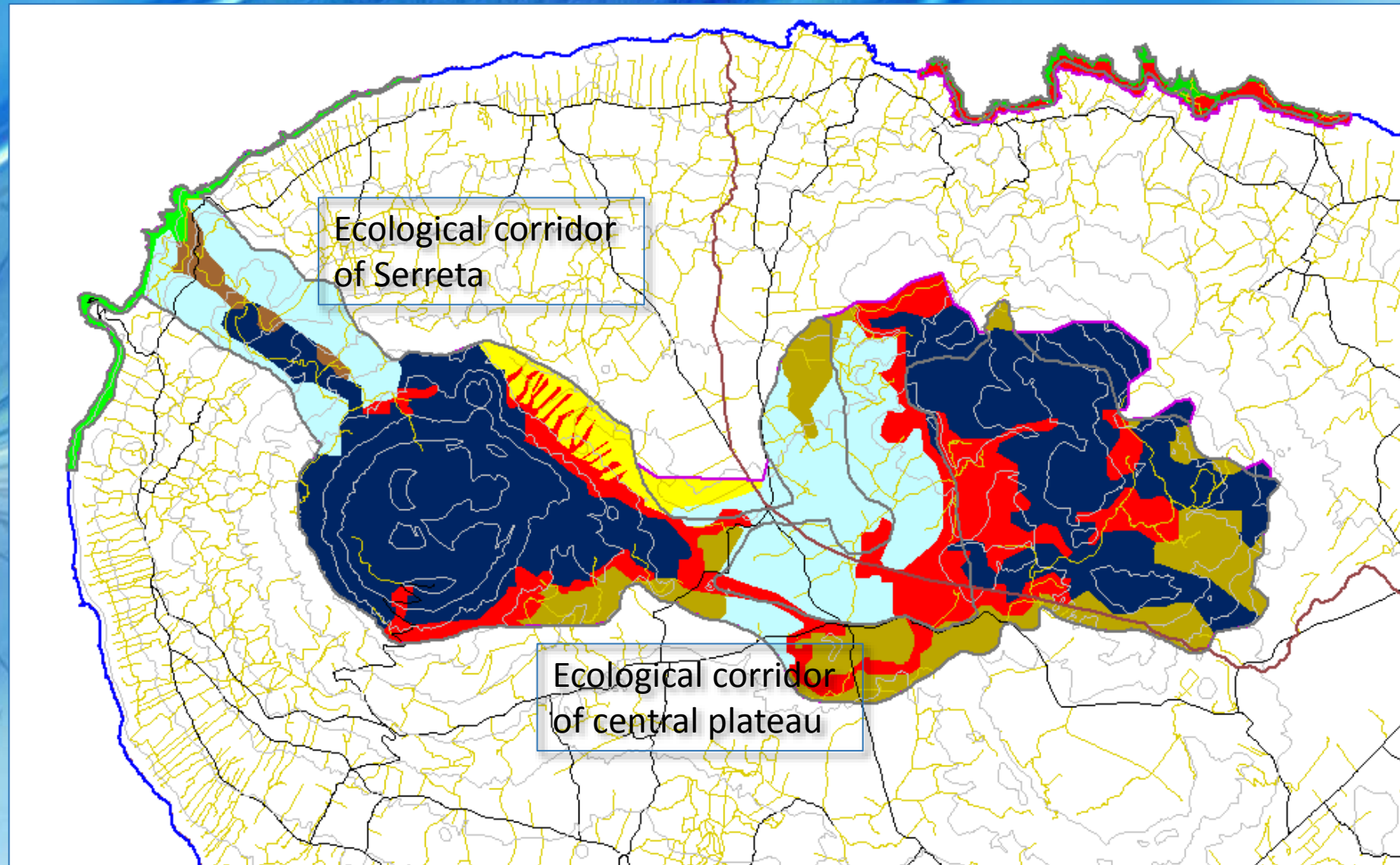
Zoning and management strategies proposed for Natura 2000 Network Areas
in Terceira island (Dias et al. 2005. Management plan for Natura 2000, Azores. SRA)

**"WETREST- WET ISLANDS RESTORATION - Insular Wetland Restoration:
Renaturalization Processes and Biodiversity Valorization in Environonmental Management"**

**"Project proposal for free access to RapidEye satellite imagery (3rd party missions)
from the European Space Agency to wetland conservation and monitoring in Azores."**
(Rapideye - "Data provided by the European Space Agency")

- The importance of peatlands and impact on the island environment

- Tools to restore the peatland and landscape stability capacities and biodiversity.

- Establishment of intervention strategies for regenerative capacity of natural ecosystems.

Study of secondary regenerative succession of Azorean Mires, after anthropogenic pressure, as an ecological restoration tool

2006
(Source of the Photo: Secretaria Regional do Turismo e Transportes dos Açores, Governo Regional dos Açores)
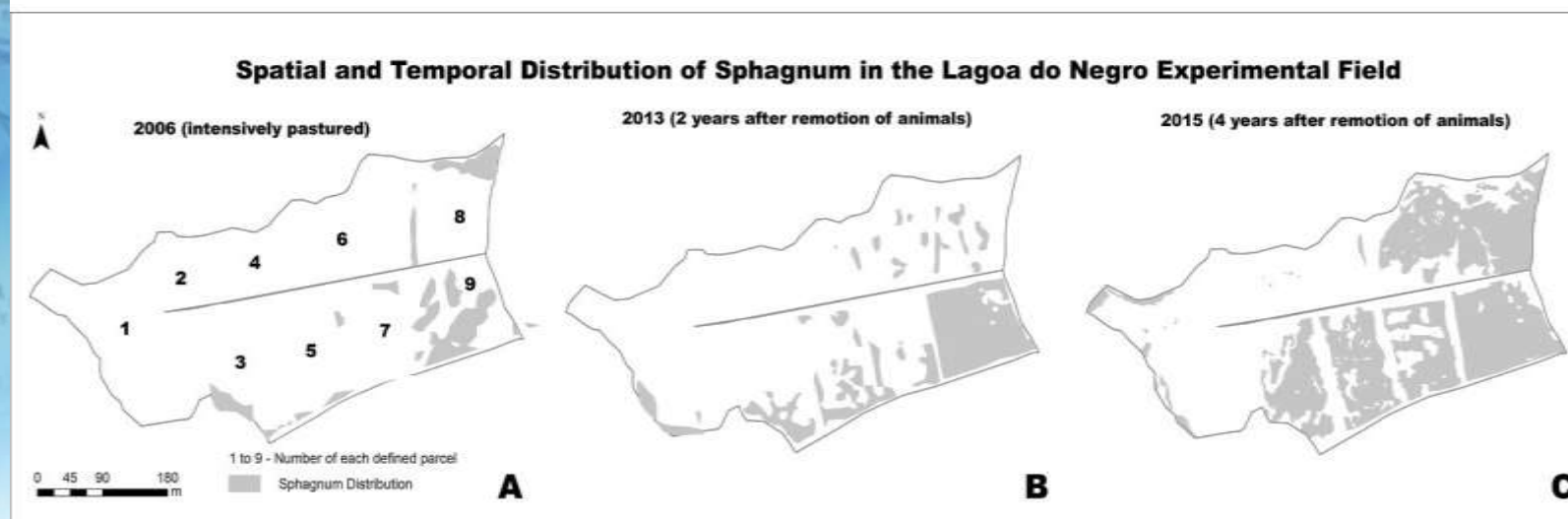
2013
(Source of the Photo: Google Earth)

2015
(Source of the Photo: Drone © Eduardo Dias)

Sphagnum distribution in Lagoa do Negro Experimental Field. The *Sphagnum* distribution area corresponds with the presence of *Sphagnum*, even in other vegetation communities.

MONITORING PLAN

BIODIVERSITY, SOIL, WATER AND HIGH CONSERVATION VALUES

FOREST CERTIFICATION

FOREST PERIMETER AND REGIONAL WOODLANDS OF SÃO MIGUEL ISLAND

The Biodiversity Monitoring is necessary to overcome two central problems to the certification process:

- To ensure that the minimum practiced standards are, in fact, at levels of minimum performance in the field (often called "efficacy of monitoring");

- Assess the extent to which existing management standards are appropriate and how these can be refined to ensure continued progress in the long - term, toward established conservation goals (often called "monitoring validation") . This is essentially the same as the applied research, as it provides a useful mechanism to learn how to improve biodiversity conservation opportunities within the certification process.
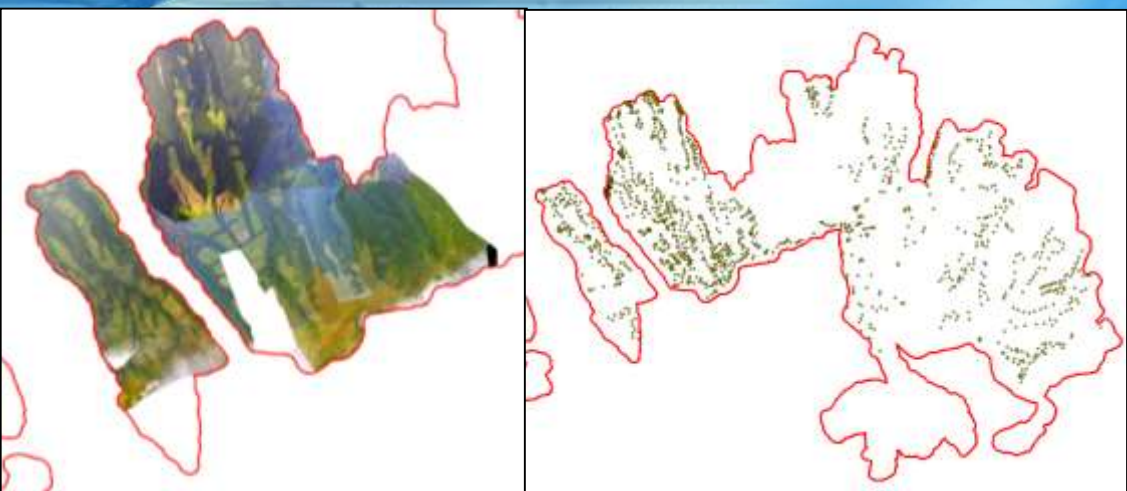
Monitorization of the change of use and land cover changes in the landscape using Remote Sensing
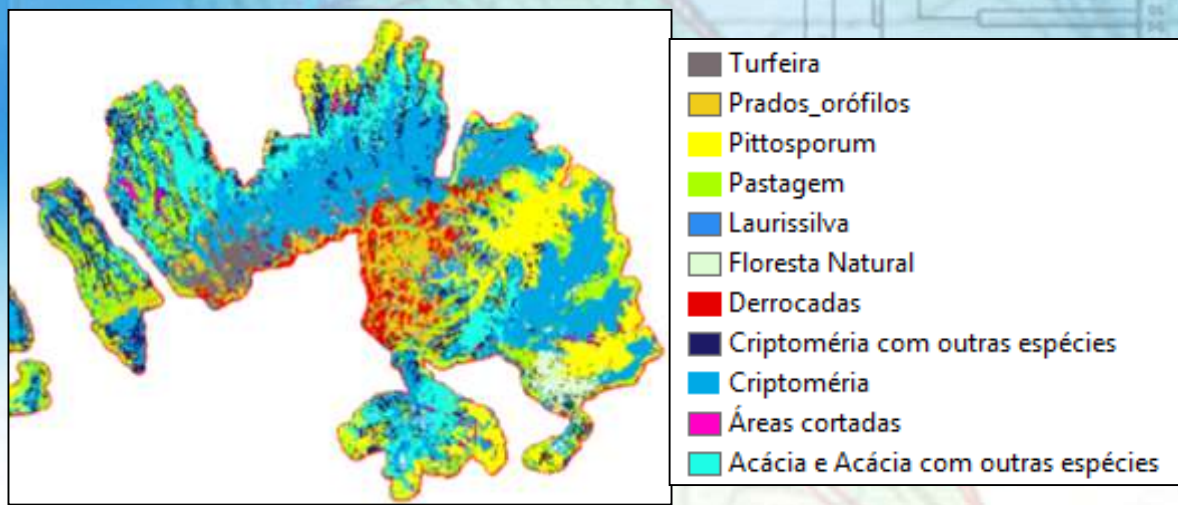

Landsat 8 image with the study area (red)

Drone survey of the area (area 1, in the first picture)

Equipamento de Detecção remota
a baixa altitude
em cartografia de habitats
GEVA - labGIS (c) direitos reservados
Universidade dos Açores

Drone Aerial photo and training points of various land uses (yellow points)

Supervised classification of the landscape, in Landsat 8

- Turfeira
- Prados_orófilos
- Pittosporum
- Pastagem
- Laurissilva
- Floresta Natural
- Derrocadas
- Criptoméria com outras espécies
- Criptoméria
- Áreas cortadas
- Acácia e Acácia com outras espécies

Remote sensing as a tool to monitorize renaturalization measures after production forest cuts

Oblique aerial photo of a forest cut

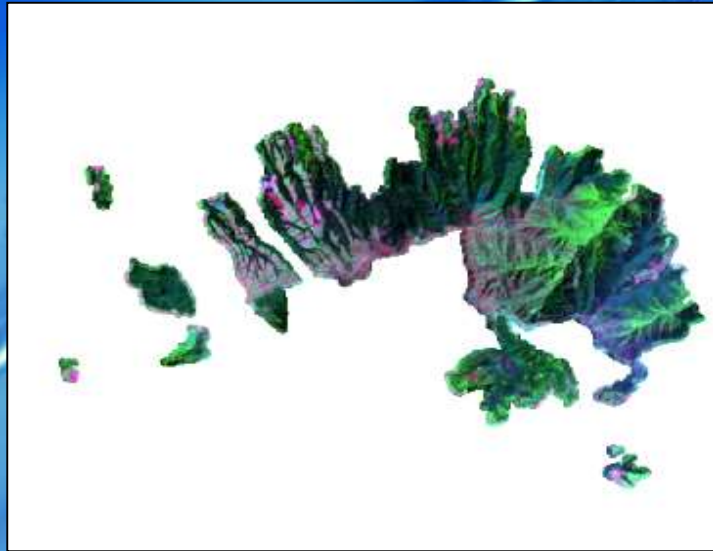Oblique aerial photo of a forest cut

Land cover provided measures to the area

Aerial photo of the forest cut area, that can be used to monitorize the land cover provided measures

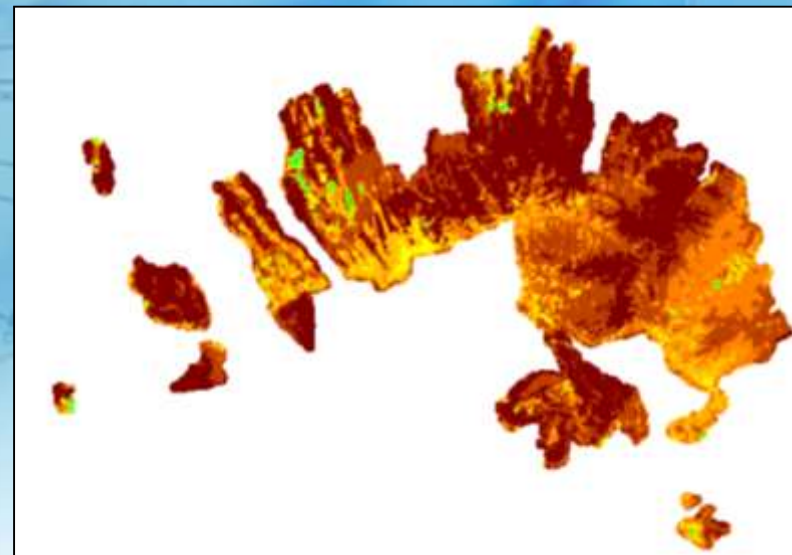# Monitorization of the vegetation evolution using Normalized Difference Vegetation Index (NDVI) in Landsat 8

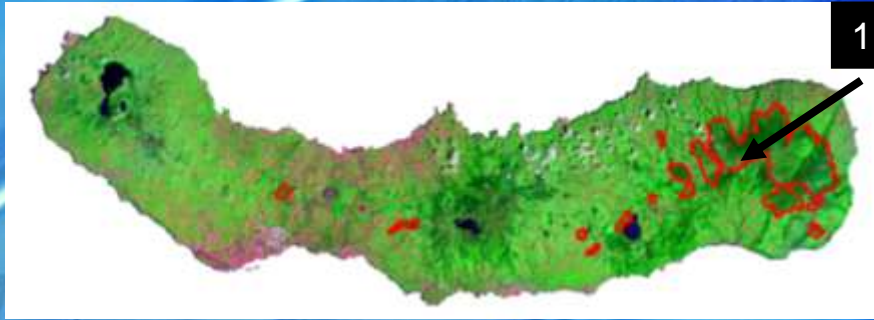

Landsat 8 image of the study area (10/8/2015)

ESTADOJUN1
- Concluído (red)
- Exploração Florestal em Execução (blue)
- Não cortado (light blue)
- Não cortado (Exploração Florestal a i (orange)

Landsat 8 image of the study area (bands 5,4,3) with forest cut areas

NDVI applied to the Landsat. The forest cut areas revealed values near zero (areas covered with few vegetation)

Monitorization of the distribution of *Sphagnum*, using Landsat 8 and Drone
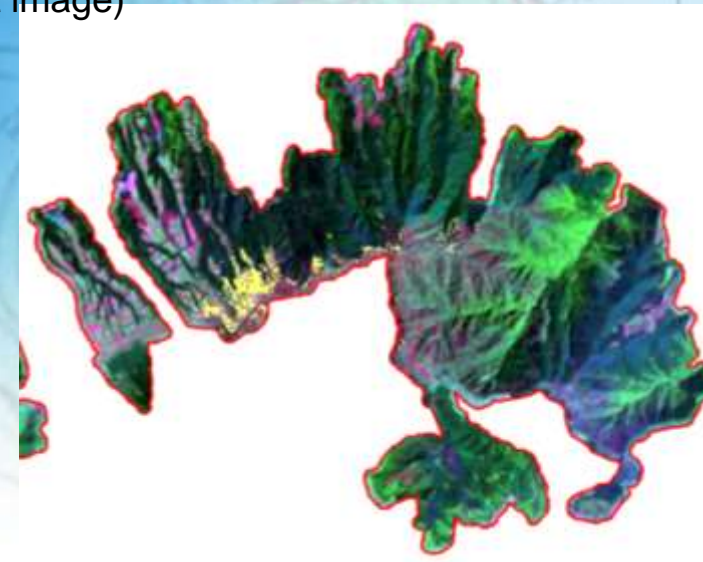

Landsat 8 image with the study area (red)

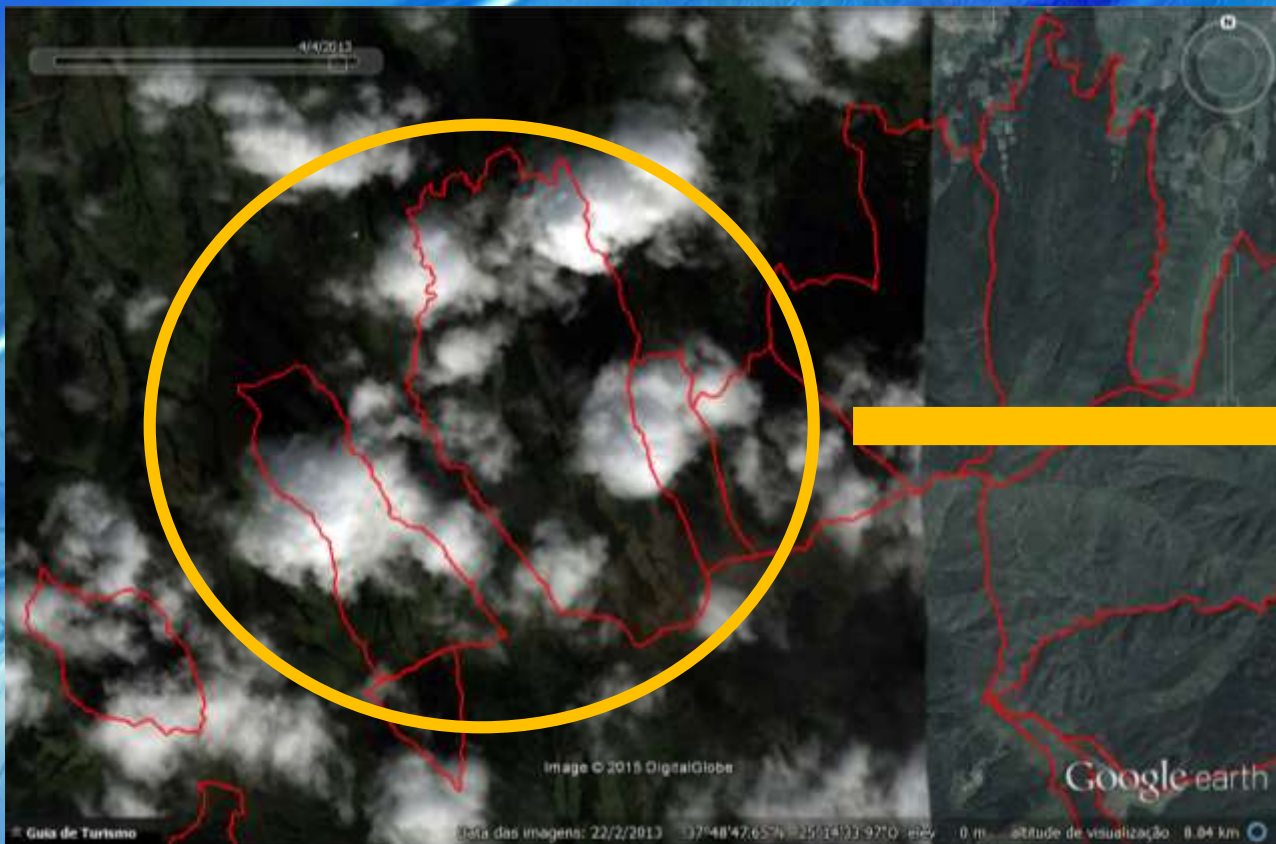Oblique aerial photo of peat bog (area 1, in the first image)

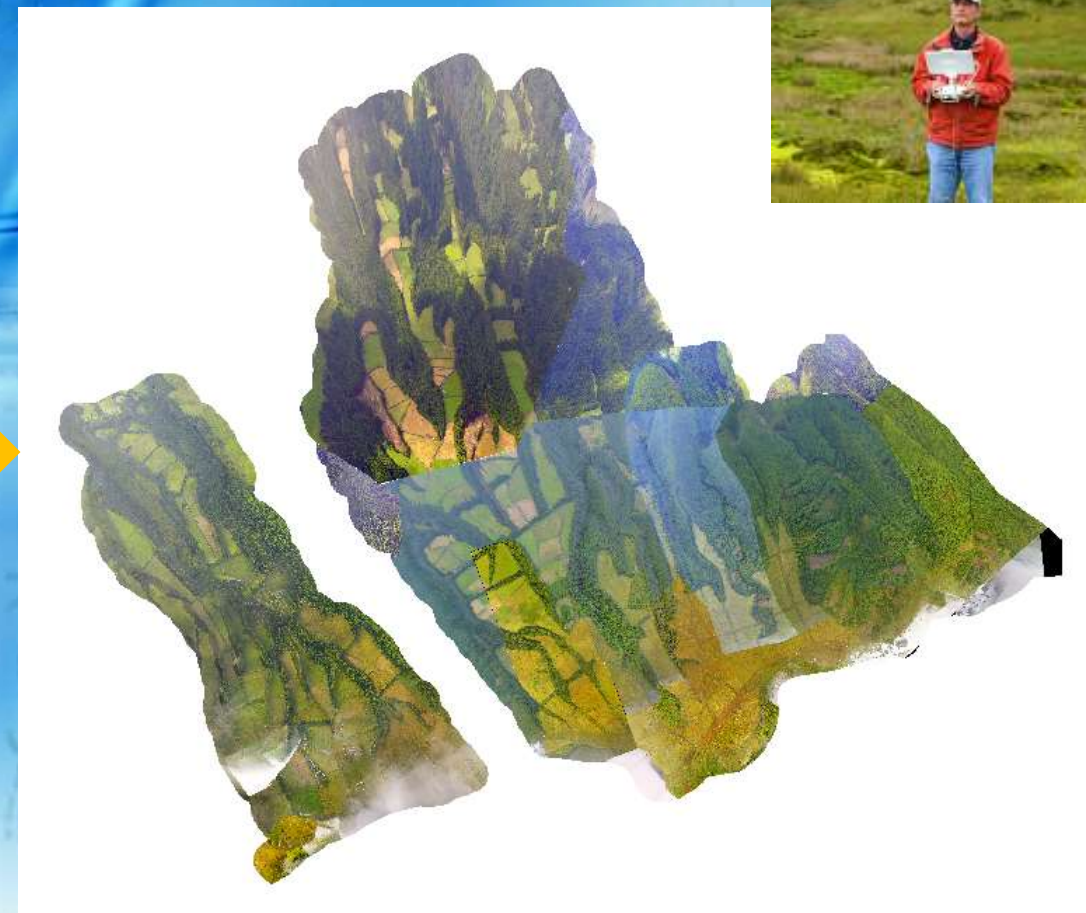Training points of *Sphagnum* sp, in the Drone Aerial photo (yellow points)

Distribution of *Sphagnum* Sp. (area 1 of the first image), in Landsat 8, according to his spectral signature

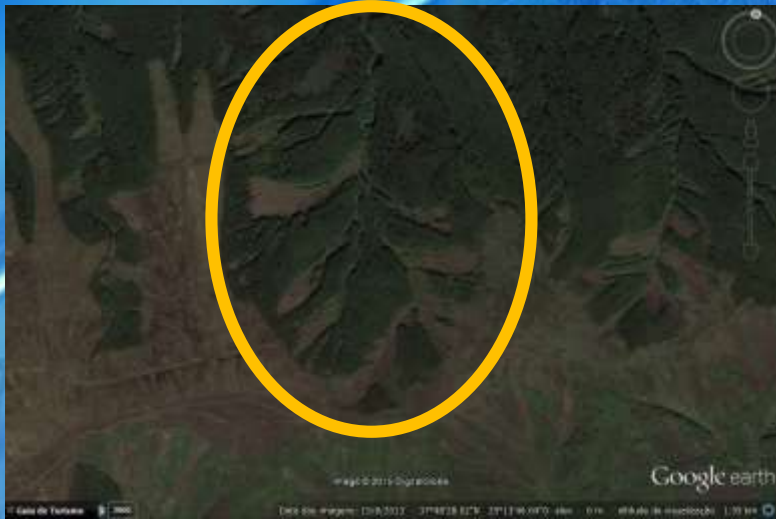**Clouds in aerial photo. Drone as a solution**

Study area
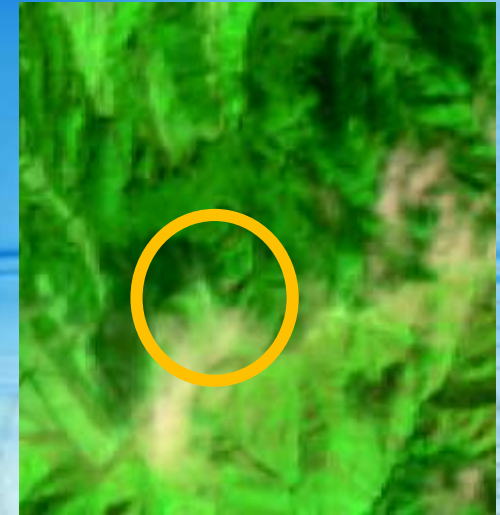(Source of the Photo: Google Earth)

Drone aerial photo

Landslides, ecosystems resilience and pioneer communities

Aerial photo (Google Earth) showing landslides in S. Miguel

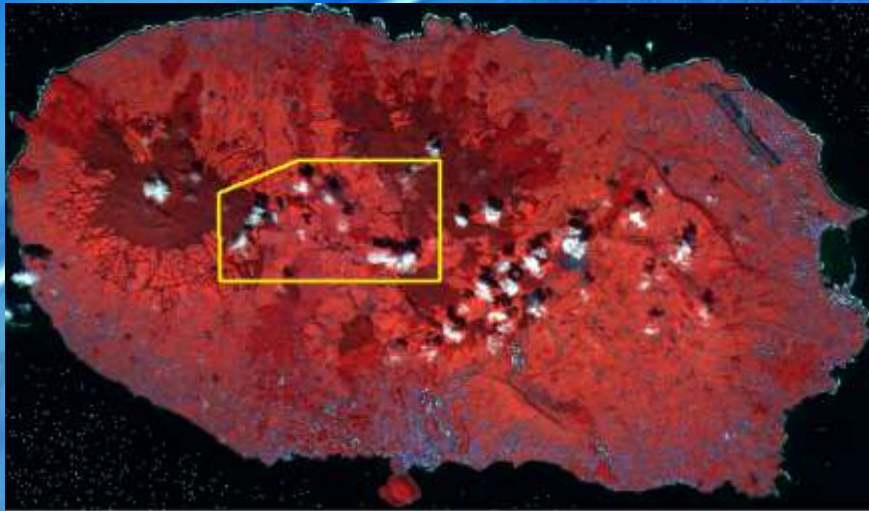The same landslides in Rapideye and Landsat 8

The same landslides in aerial photo from drone

The drone has the possibility to oblique aerial photos, allowing better resolution of the area

Modelling of ecosystem services such as carbon sequestration, water retention and biodiversity
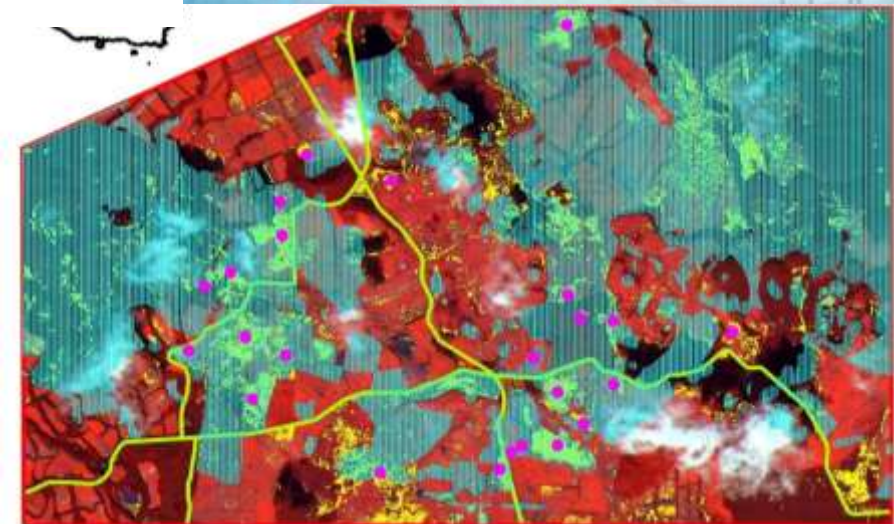

Location of the study area in Terceira island

Aspect of the study area, with the presence of *Sphagnum* sp. and hydromorphic habitats

Presence of *Sphagnum*, according to the analysis of the Rapideye

Validation of the presence of *Sphagnum*

(Rapideye - "Data provided by the European Space Agency")

Modelling of ecosystem services such as carbon sequestration, water retention and biodiversity
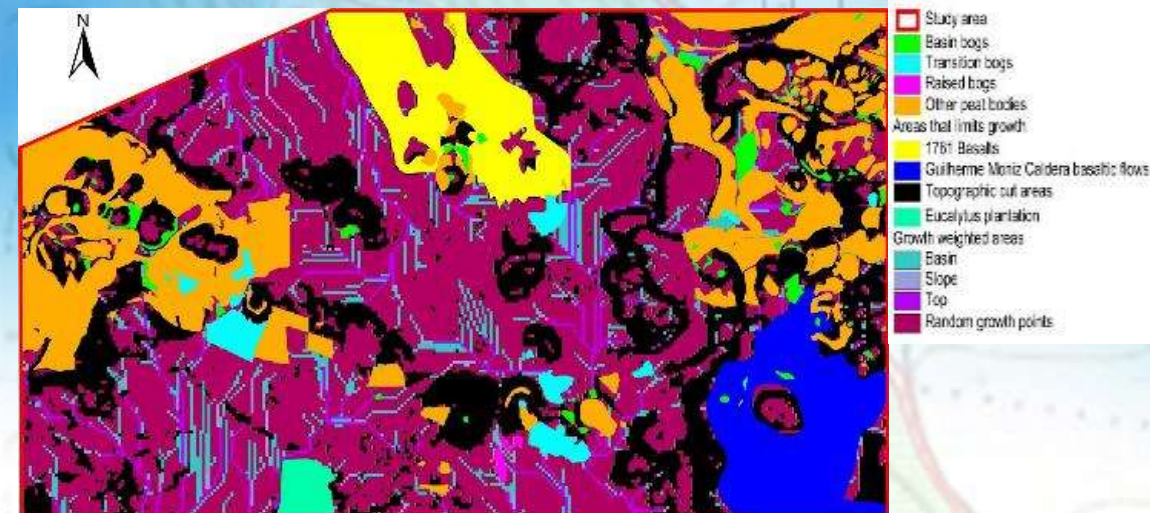

Ground-penetrating Radar applied to stratigraphy of the hydromorphic habitats

Core sampling of the hydromorphic habitats

Laboratory measurements of water and Carbon

GIS modellation scenarios of water and Carbon stocks and sequestration

Sentinel-2

Potential applications in Ecological management and vegetation mapping

Copernicus/GMES data policy:

"Full and open access to Sentinel data for all users." [1]

S1A/B:	Radar Mission	3 Apr 2014/early 2016
S2A/B:	High Resolution Optical Mission	June 2015/2016
S3A/B:	Medium Resolution Imaging and Altimetry Mission	end 2015/2017
S4A/B:	Geostationary Atmospheric Chemistry Mission	2021/2027
S5P:	Low Earth Orbit Atmospheric Chemistry Mission	2016
S5A/B/C:	Low Earth Orbit Atmospheric Chemistry Mission	2021/2027
S6A/B:	Altimetry Mission	2020/2025

Sentinel-2 can be interesting in vegetation studies and habitat management of the azores

[1] - https://directory.eoportal.org/web/eoportal/satellite-missions/c-missions/copernicus

Habitat Automatic Classification – Limitations. Can Sentinel help?
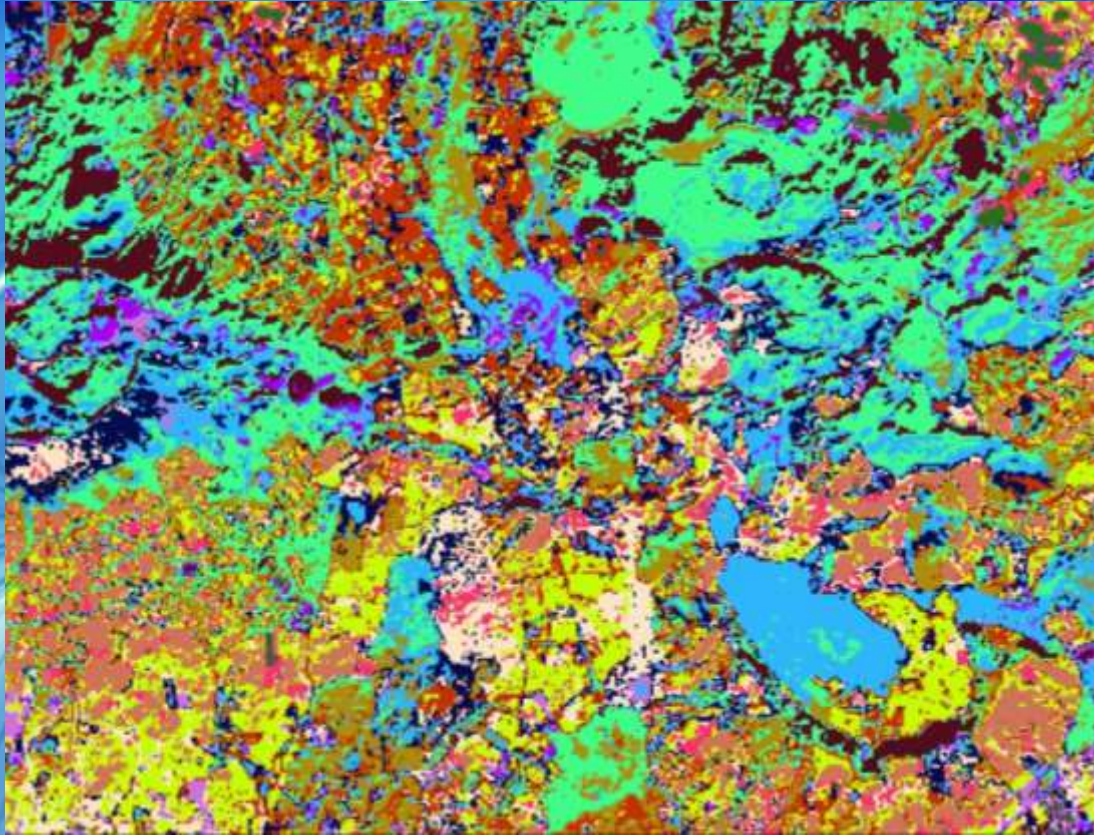
Landsat 8 with iso cluster unsupervised classification with 15 classes

Peat Bogs types and distribution at Terceira Island - GEVA
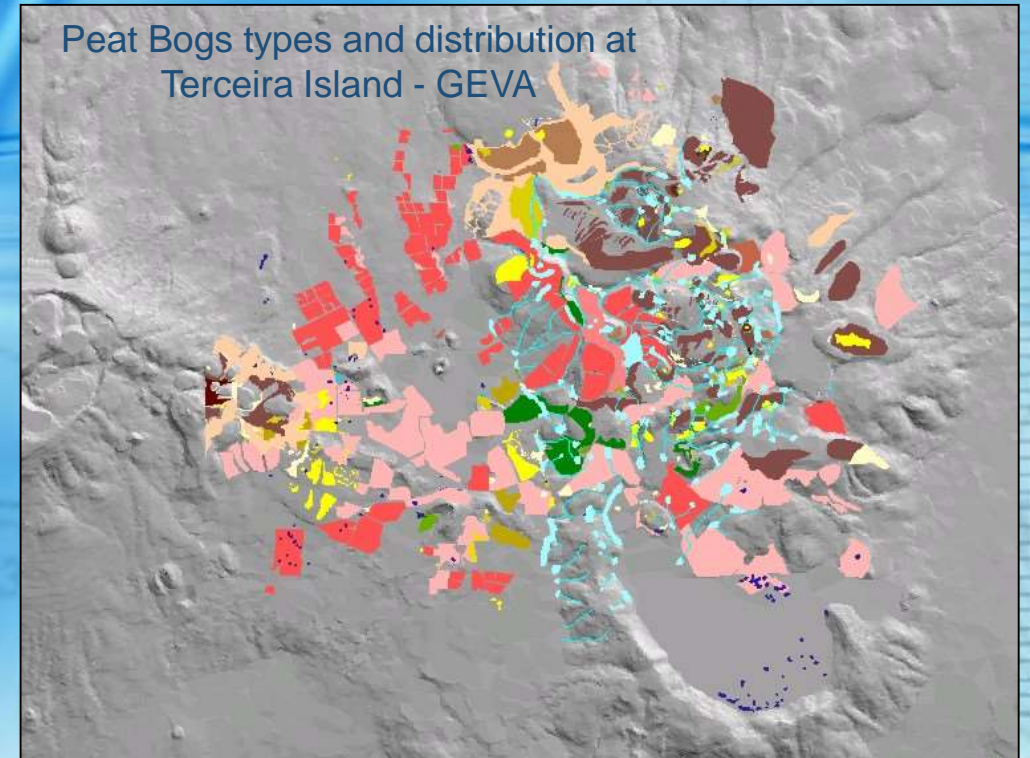
Peat Bogs types and distribution at Terceira Island - GEVA

Hydrological Availability Annual Index (IADH) – can Sentinel-2 help?
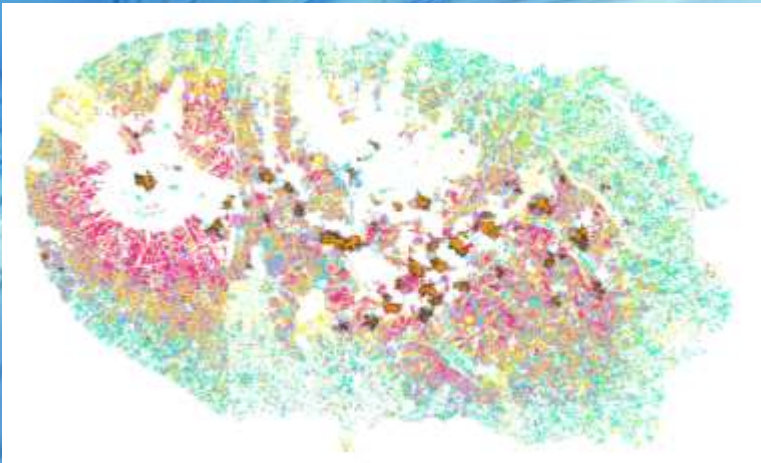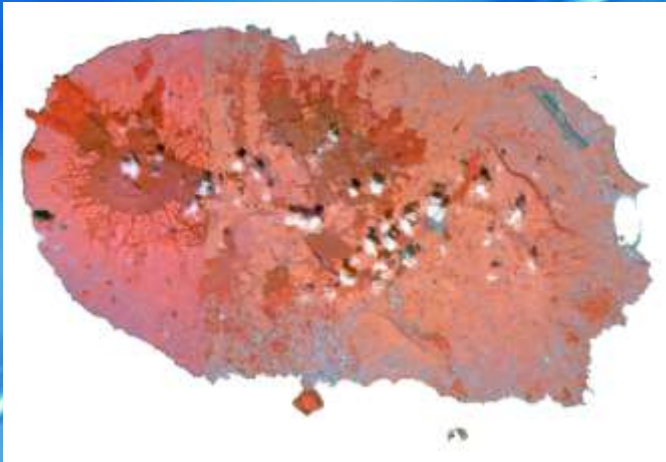
Hiper-húmido
Supra-oceânico
Oceânico

IADH
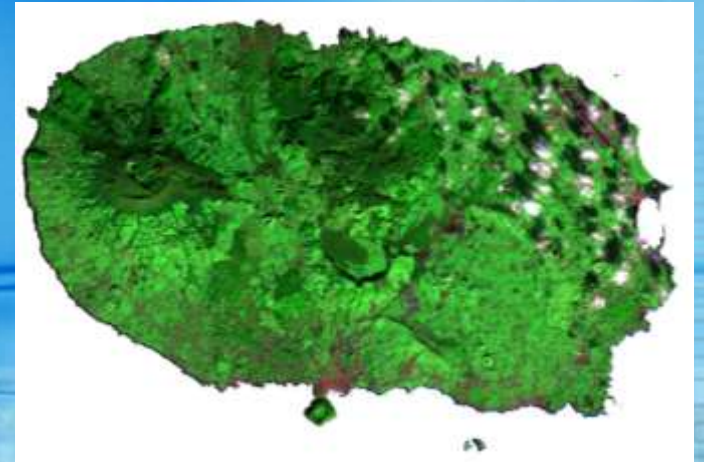
Rapideye with iso cluster unsupervised classification with 15 classes, only showing the ones that intersect pastures
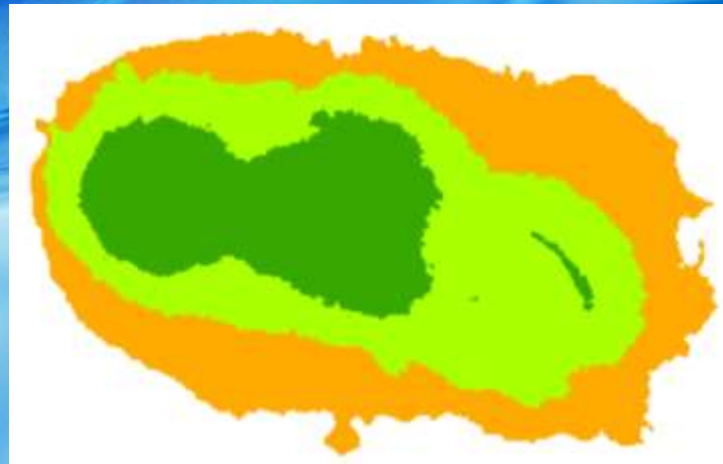
Landsat 8 with iso cluster unsupervised classification with 15 classes, only showing the ones that intersect pastures

Special habitats – can Sentinel-2 help find them?

Thermophillous habitats in volcanic fields
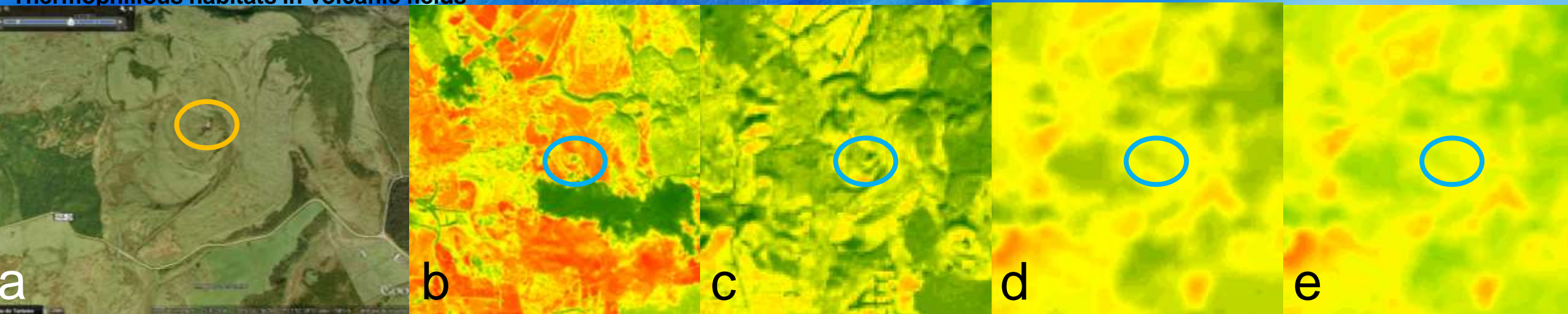
Google Earth photo of the Fumarolas, in Terceira island (a), a thermophiles habitat. The thermal irradiation was no possible to be identified in Rapideye NIR band (b), or in band 5, 10 or 11 of Landsat 8 (c, d and e). More *investigation*, or more *spectral and spatial resolution* are needed.

Drone aerial photography of Fumarolas, in Terceira island

Sentinel-2 is a polar-orbiting, multispectral high-resolution imaging mission for land monitoring to provide, for example, imagery of vegetation, soil and water cover, inland waterways and coastal areas. Sentinel-2 can also deliver information for emergency services [2].

[3]

- *Free?*
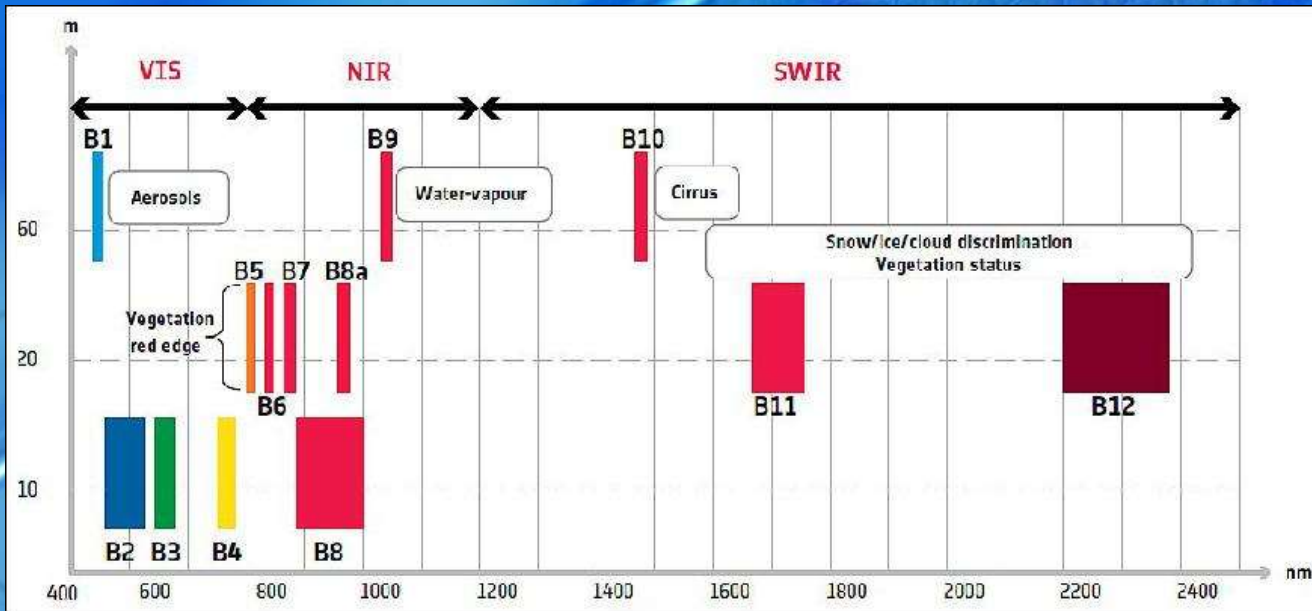- *Monitorization with 10 to 60 m of spatial resolution?*
- *Objective to provide cloud-free products typically every 15 to 30 days over Europe and Africa. And about the Azores?*
- *Revisitation time (problems with clouds) of 5 days?*
- *13 spectral bands!*
- *Will be possible to minimize the problem of too much water in Azores (in the grasslands, for instance), to differentiate landscape elements (maybe with the 3 RedEdge bands)?*
- *Indices, such as leaf area index, leaf chlorophyll content and leaf water content can be a problem with too much water.*
- *Monitorization of forestation?*
- *Landslides?*

Spectral bands (center wavelength in nm/SSD in m)	Mission objective	Measurement or calibration
B1 (443/20/60), B2 (490/65/10) & B12 (2190/180/20)	Aerosols correction	Calibration bands
B8 (842/115/10), B8a (865/20/20), B9 (940/20/60)	Water vapor correction	
B10 (1375/20/60)	Circus detection	
B2 (490/65/10), B3 (560/35/10), B4 (665/30/10), B5 (705/15/20), B6 (740/15/20), B7 (775/20/20), B8 (842/115/10), B8a (865/20/20), B11 (1610/90/20), B12(2190/180/20)	Land cover classification, Leaf chlorophyll content, leaf water content, LAI, fAPAR, snow/ice/cloud, mineral detection.	Land measurement bands

[3]

Interesting bands!

[2] - http://www.esa.int/Our_Activities/Observing_the_Earth/Copernicus/Overview4
[3] - https://directory.eoportal.org/web/eoportal/satellite-missions/c-missions/copernicus-sentinel-2

Thank you!

For more information:

- Dias E (1996). Vegetação Natural dos Açores. Ecologia e Sintaxonomia das Florestas Naturais. Ph.D. thesis. Universidade dos Açores. Angra do Heroísmo.
- Mendes (*In development*). Study of secondary regenerative succession of Azorean Mires, after anthropogenic pressure, as an ecological restoration tool.
- Pereira, Diana C. (2011). Modelos Ecológicos para implementação de Planos de Renaturalização – Caso da Fajã do Calhau (São Miguel). Tese de Mestrado em Engenharia do Ambiente. Universidade dos Açores. Angra do Heroísmo.
- Pereira, Dinis (*Submitted*). Avaliação do valor dos ecossistemas de turfeiras dos Açores, com recurso a modelação em Sistemas de Informação Geográfica. Ph.D. thesis.
- http://eduardodias.com.pt/