

# ***MAPinvasive***

**Using Remote Sensing to map, monitor and manage Invasive Alien Plants in “Pico da Vara” Special Protected Area (S. Miguel Island, Azores Archipelago, Portugal)**

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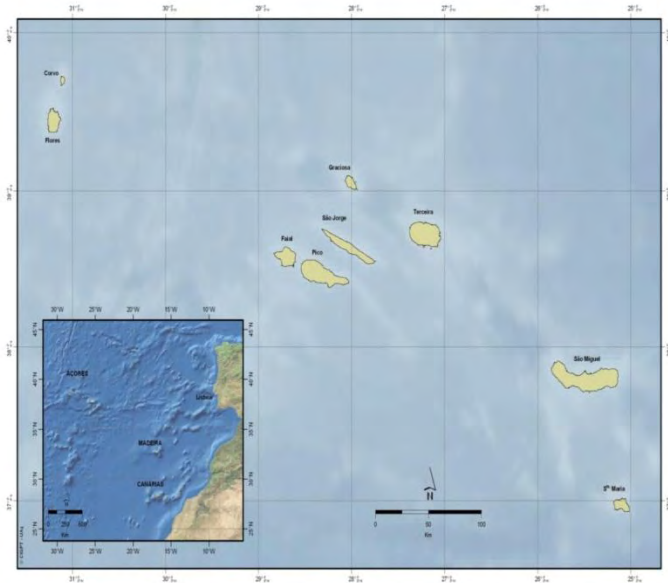
# Outline

- **Alien Invasive Species (AIS): threatening biodiversity in Azores islands**
- **Azores Islands & Remote Sensing Data: a very unlucky combination**
- **MAPinvasive: mapping AIS in Azores Islands for management support**

# Alien Invasive Species: threatening biodiversity in Azores islands

The Azores Archipelago:

- Portuguese autonomous region
- North Atlantic Ocean, about 1,500 km from Lisbon and about 3,900 km from the East Coast of North American continent.
- These islands extends along a NW-SE strip
- They are divided in three groups based on their relative proximity: the Western Group including Flores and Corvo islands, the Central Group including Pico, Faial, S. Jorge, Graciosa and Terceira and the Eastern Group including S. Miguel and S. Maria islands.



# Alien Invasive Species: threatening biodiversity in Azores islands

- S.Miguel Island: the biggest and most populated island within the Azores archipelago, located in the North Atlantic Ocean, about 1500 km from Europe.
- Vascular plant flora consisting of approximately 1000 taxa, largely dominated by non-indigenous taxa: 66% (Silva & Smith, 2004)
- Azores Archipelago is the second “most invaded” archipel in the world after Hawaii Archipelago
- Existing indigenous vascular plant taxa are particularly important because they compose a very valuable ecosystem: the Azorean Laurel Forest
- Most important occurrence area: ‘Pico da Vara’ Protected Area (also a Natura 2000 Network Site).



# Alien Invasive Species: threatening biodiversity in Azores islands

“Pico da Vara” SPA (Special Protected Area):

- Located in the mountain complex of Serra da Tronqueira, in the eastern part of S. Miguel Island (Archipelago of Azores, Portugal), and includes large portions of Nordeste and Povoação municipalities.
- Rapid spread of *Pittosporum undulatum* (“Sweet Pittosporum”), a very aggressive invasive alien plant species, is causing serious damage to this native ecosystem.
- Its direct competition with native species has resulted in a significant decline in native populations and ecosystem area. Pico da Vara is a 6000 hectares' Protected Area and also a Natura 2000 Network Site.



# Alien Invasive Species: threatening biodiversity in Azores islands

“Pico da Vara” SPA (Special Protected Area):

- The presence of an endemic bird called “Priolo” (*Pyrrhula murina*), the most threatened *passeriform* in Europe is the cause of the classification as SPA – Special Protected Area (Birds European Directive).
- Drastic reduction of Priolo population along the last 40 years is directly associated with fragmentation and reduction of Laurel Forest area in Pico da Vara.
- The extinction of Priolo stills a serious threat that is being mitigated thanks to huge conservation projects like LIFE Priolo (Birdlife International), that aimed to restore about 300 ha of this native habitat until 2008.



# Alien Invasive Species: threatening biodiversity in Azores islands

*Pittosporum undulatum* Vent.

“Sweet Pittosporum”

Micro-mesophanerophyte. Tree up to 10-15 m, with gray ritidome. Leaves petiolate, ovatelanceolate, acute, glabrous, with undulated margins. Flowers aromatic with white, lanceolate petals, clustered in umbelliform cymes. Capsules obovate, glabrous, bivalve, orange when ripe. Seeds immersed in mucilage. Sexual reproduction (hundreds to thousands of seeds/plant/year). **Native from Australia. Intentional introduction in Azores Archipelago (hedgerows, ornamental).** Natural dispersal by endozoochory, through use in hedgerows and fodder. (Silva & Smith, 2004)



# Alien Invasive Species: threatening biodiversity in Azores islands

*Other Alien Invasive Species are threatening Laurel Forest in Azores Islands and “Pico da Vara” Special protected Area:*

*Acacia melanoxylon* (Native from Australia)

*Hedynchium gardnerianum* (Native from Himalaya)

*Clethra arborea* (Native from Madeira Island)

*Gunnera tinctoria* (Native from Chile)

*Sphaeropteris cooperi* (Native from New Zealand)



# Alien Invasive Species: threatening biodiversity in Azores islands

## *Monitoring invasive alien plant species in 'Pico da Vara' SPA*



Since 2004, all the monitoring data used for invasive species management in Pico da Vara Special Protected Area has been obtained by expensive field work methods:

- Twenty 10x10 meters random plots
- Ninety 2x2 meters random plots.

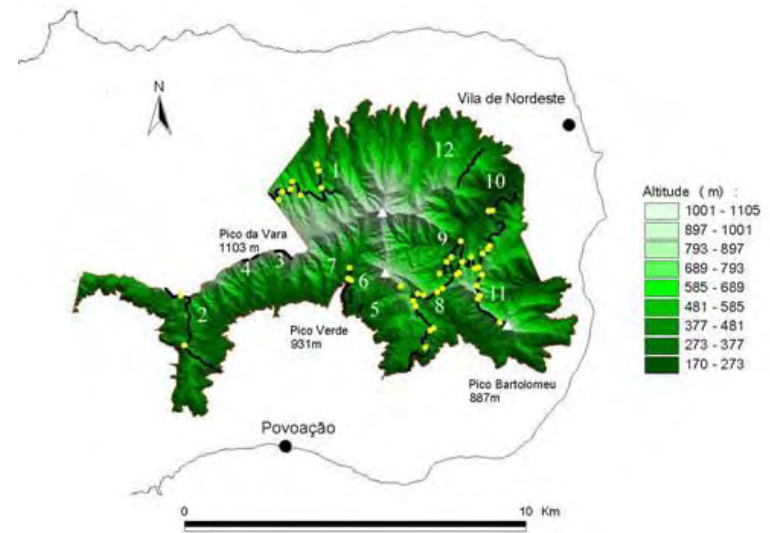
# Alien Invasive Species: threatening biodiversity in Azores islands

## ***Monitoring invasive alien plant species in 'Pico da Vara' SPA***

- Although this information is very valuable and still needed, it only covers and characterizes a very small part of the total SPA area (about 6000 hectares).
- The integration of geospatial technologies as Remote Sensing and GIS can reduce costs and increase the efficiency and effectiveness of invasive management program for certain species that spread in homogeneous, dense and large populations like *Pittosporum undulatum*.

# Azores Islands & Remote Sensing Data: a very unlucky combination

Due to the specific geographic location of S.Miguel Island (in the middle of Northern Atlantic Ocean) and because of the climatic (cloudy and very humid) and geomorphologic characteristics (very steepy) of 'Pico da Vara' SPA, the availability of remote sensing images covering these area is very limited.



# Azores Islands & Remote Sensing Data: a very unlucky combination

Several types of ortho-rectified remote sensing images covering 'Pico da Vara' SPA have been identified and obtained to be used in this study, as it follows:

- **Black & White** (1997) and **Coloured** (2005) **orthophotomaps** ;
- Medium-spatial resolution multispectral images: **Landsat** (1998, 2001, 2002, 2006); **SPOT** (2000, 2003, 2005, 2006)
- High-spatial resolution multispectral images: **Ikonos** (2005)
- Hyperspectral images: **Hyperion** (2001); **Chris-Proba** (2006)

# MAPinvasive: mapping AIS in Azores Islands for management support

MAPINVASIVE is a PhD research project which goal is designing a cost-effective and reliable methodology to map and monitor invasive alien plant populations of *Pittosporum undulatum* across Pico da Vara Special Protected Area for management support-decision, using low-cost or free-of-charge (e.g. using ESA Category-1 PI Programme) optical remote sensing data (Orthophotomaps, Hyperspectral and Multispectral Satellite Imagery).

# MAPinvasive: mapping AIS in Azores Islands for management support

## Why *Pittosporum undulatum* as target species?

- Spreading in homogeneous, dense and large patches usually bigger than 1000 m<sup>2</sup> (“compatible” with Landsat ETM pixel spatial resolution = 900 m<sup>2</sup> in spectral bands and 225 m<sup>2</sup> in panchromatic band)
- Inexistence of “above forest cover” in the same patch
- Very particular forest structure, easily distinguishable from surrounding coniferous forest (*Cryptomeria japonica*) and native forest (mostly shrubland), the most common vegetation covers in “Pico da Vara” SPA.

# MAPinvasive: mapping AIS in Azores Islands for management support

**Why *Pittosporum undulatum* as target species?**

*Pittosporum undulatum* can be potentially suitable for energy production through biomass gasification and pyrolysis (Green Island / MIT Portugal Project) = “Sinergy” between Nature Conservation and “Green” Energy Production?

# MAPinvasive: mapping AIS in Azores Islands for management support

Some hypothesis to test regarding Imagery Type:

- 1) **Medium Spatial Resolution Multispectral Images** (Landsat ETM, SPOT) are suitable for *Pittosporum undulatum* detection and mapping (Peterson, 2003; Anderson & Everitt, 1993)
- 2) **High Spatial Resolution Multispectral Images** (Ikonos) are suitable for *Pittosporum undulatum* detection and mapping (Katoh, 2004)
- 3) **Orthophotomaps** are suitable for *Pittosporum undulatum* detection and mapping (Caridade *et al.*, 2008)
- 4) **Hyperspectral Images** (Hyperion, Chris-Proba) are suitable for *Pittosporum undulatum* detection and mapping (Thenkabail *et al.*, 2004; Underwood *et al.*, 2003)

# MAPinvasive: mapping AIS in Azores Islands for management support

How to try to achieve it? Some possible strategies:

## 1) Unsupervised Classification:

- Multi-strategies classification: e.g. KMEANS + ISODATA + SOM

(Gançarski & Wemmert, 2007)

- Multi-sources classification: e.g. Landsat + SPOT  
(Forestier *et al.*, 2008)

# MAPinvasive: mapping AIS in Azores Islands for management support

How to try to achieve it? Some possible strategies:

## 2) Supervised Classification:

- 250 training sites within *Pittosporum undulatum* patches
- The Azorean Regional Forest Inventory, available in GIS format, has been produced from 1997's Black & White orthophotomaps photo-interpretation complemented by *in situ* data validation through field work. It includes data on the distribution and dominance of *Pittosporum undulatum* at a 100 x 100 meters grain.

NOTE: Both datasets can also be used for accuracy assessment of any further classification method application (1) (3)

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**How to try to achieve it? Some possible strategies:**

## **3) Texture Analysis (Caridade *et al.*, 2008)**

- Black & White Orthophotomaps
- Panchromatic images (Landsat and Quickbird)

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## Expected outcomes:

- The most accurate methods for orthophotomaps and satellite optical/NIR (multispectral and hyperspectral) images classification for *Pittosporum undulatum* mapping will be identified and developed.
- In parallel, orthophotomaps and satellite remote sensing images effectiveness for *Pittosporum undulatum* mapping will be assessed.

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## Expected outcomes:

- A multi-temporal (1997-2007) spread evolution study of *Pittosporum undulatum* in Pico da Vara SPA could be probably the most important expected output of this research project. This cartography will be very important for the ecological study (allowing more accurate modeling) of the species and for its *in situ* management decision-support system.

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## Potential development of this research project:

- Biomass estimation (Green Energy Production; Carbon Sequestration; etc)
- Update of the Azorean Regional Forest Inventory
- Ecological Modelling for AIS management decision-support system
- Integration of SAR (Alos Palsar, Radarsat-2) data for forest structure and biomass studies

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# ACKNOWLEDGEMENTS

This Ph.D. Research Project (M3.1.2/F/025/2007) is supported by the Azorean Secretary of Science, Technology and Equipments. I especially thank Helena Calado (University of the Azores) and Agustin Lobo (The Institute of Earth Sciences Jaume Almera – CSIC) for their academic support.

**Thanks for your attention!**

**OBRIGADO 😊**