La Palma, Spain
Mountain & Coastal Ecosystem

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Invasive species impact endemic species and their contribution to functioning and services of islands

Fig. 1. North coast at La Palma, hosting isolated and inaccessible habitats of threatened species. Although human impact does not exist here, alien herbivore pressure is very high.

La Palma is a volcanic oceanic island characterized by topographic complexity and climatic diversity, steep slopes and erosion (Fig. 1). Endemic species, such as *Pinus canariensis,* are covering still large parts of the island and are controlling ecosystem functions and services until today. Drinking and irrigation water, timber, fodder, slope stability, attractive species, ecosystems and landscapes are values closely linked with provisioning, regulating, supporting and cultural services of endemic species.

The standard of living and the maintenance of societal and economic structures on oceanic islands are particularly threatened by introduced species, land use change and climate change, particularly via extreme weather events.

Problem Statement

Islands are of outstanding importance for speciation and for the development of species diversity. They host a high number and a high proportion of endemic species (Fig. 2). Island species are highly threatened by global extinction due to non-native herbivory and human-introduced invasive species.

In consequence, biodiversity loss and subsequent loss of ecosystem functioning and services is likely to occur if no counteractive measures are implemented in order to avoid threats and restrictions for humans on islands that are directly dependent on the services provided by nature.

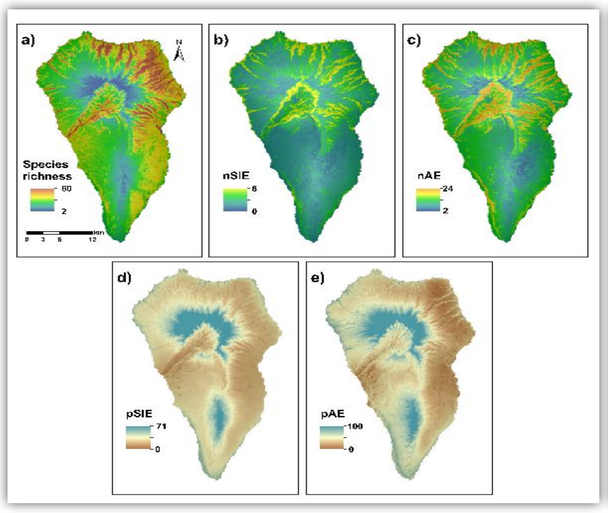

Fig. 2.a) species richness, b) # single-island endemics, c) number of archipelago endemics, d) percentage of single-island endemics, e) percentage of archipelago endemics.

Fig. 3. Individuals of the single remnant population of *Lotus eremiticus*, threatened by extinction due to intense browsing by introduced herbivores (rabbits, goats).

Drivers of change

- **Climate Change:** Cloud fog drip is a main source for island precipitation (Fig. 4). Effects of warming and extreme drought are unclear.
- **Invasive herbivores:** Island species are not adapted to introduced herbivores, which do increase their extinction risk (Fig. 5).
- **Fires:** Island species such as *Pinus canariensis* are adapted to fire but fire frequency increases due to anthropogenic ignitions.
- **Land use change:** Abandonment of traditional land use and intense cultures, both, are rapidly modifying cultural landscapes.

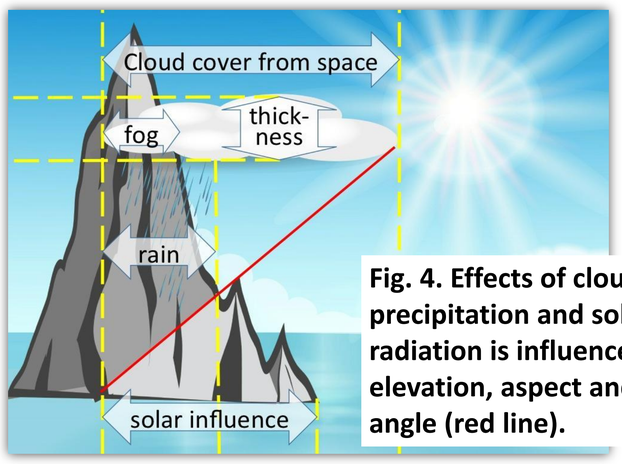

Fig. 4. Effects of clouds on precipitation and solar radiation is influenced by elevation, aspect and sun angle (red line).

Fig. 5. Strong browsing impact of rabbits on the single-island endemic *Genista benehoavensis,* a subalpine species close to extinction.

Linking RS and in-situ Data

- **Fire detection:** Through direct detection but also via Fuel Moisture Content (FMC) (Fig. 6).
- **Human component:** land use, land cover classes, settlements, infrastructure.
- **Atmospheric indicators:** Area of cloud cover, fog contact zone with land surface, cloud thickness, cloud precipitation, solar radiation.
- **Regional climatic models** on current and future climatic conditions
- **Habitat characteristics:** soil moisture, DGM, among others.
- **Vegetation characteristics:** (e.g. alpha, beta, gamma diversity of plant species), linked with NDVI, NDWI, LAI, fPAR, GPP.

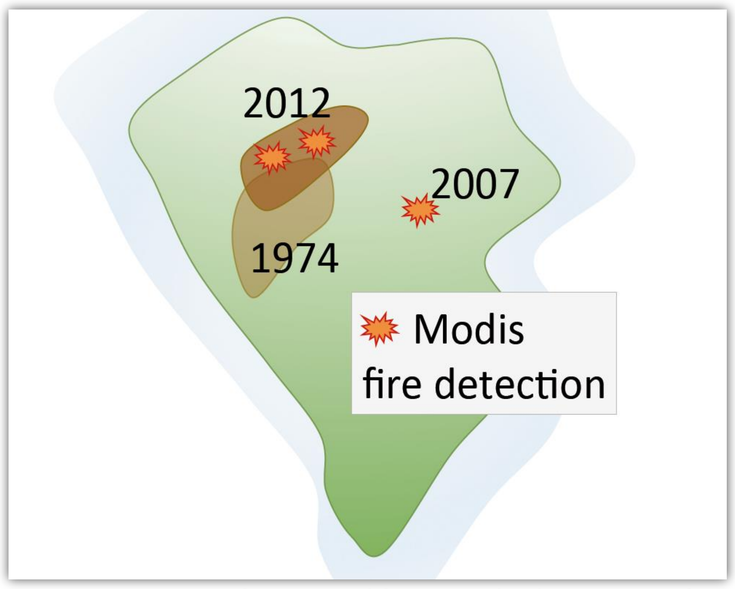

Fig. 6. An example on problems with the MODIS fire detection product on La Palma Island. Brown areas reflect historically verified burnt areas, whereas some MODIS-detected fire pixels have actually never burnt. The error is likely caused by highly tempered rocky surface.

Research questions and challenges

1. How do non-native herbivores affect the spatial pattern of endemic plant species and the ecosystems services connected to these species?
2. Does the interaction of non-native herbivores and fire cause degradation of island ecosystems?
3. Which are the areas of highest risk to loose ecosystem services as a result of invasion, anthropogenic disturbances and climate change?
4. How are various aspects of biodiversity linked with environmental conditions and with ecosystem structure, functioning and services?

Master and PhD thesis topics

- ✓ Linking Earth Observation with island ecosystems under conditions of complex topography
- ✓ Modelling future trends in the populations of single-island endemic plant species on La Palma
- ✓ The contribution of disturbances to maintain ecosystem functioning on oceanic islands

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