This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 641762

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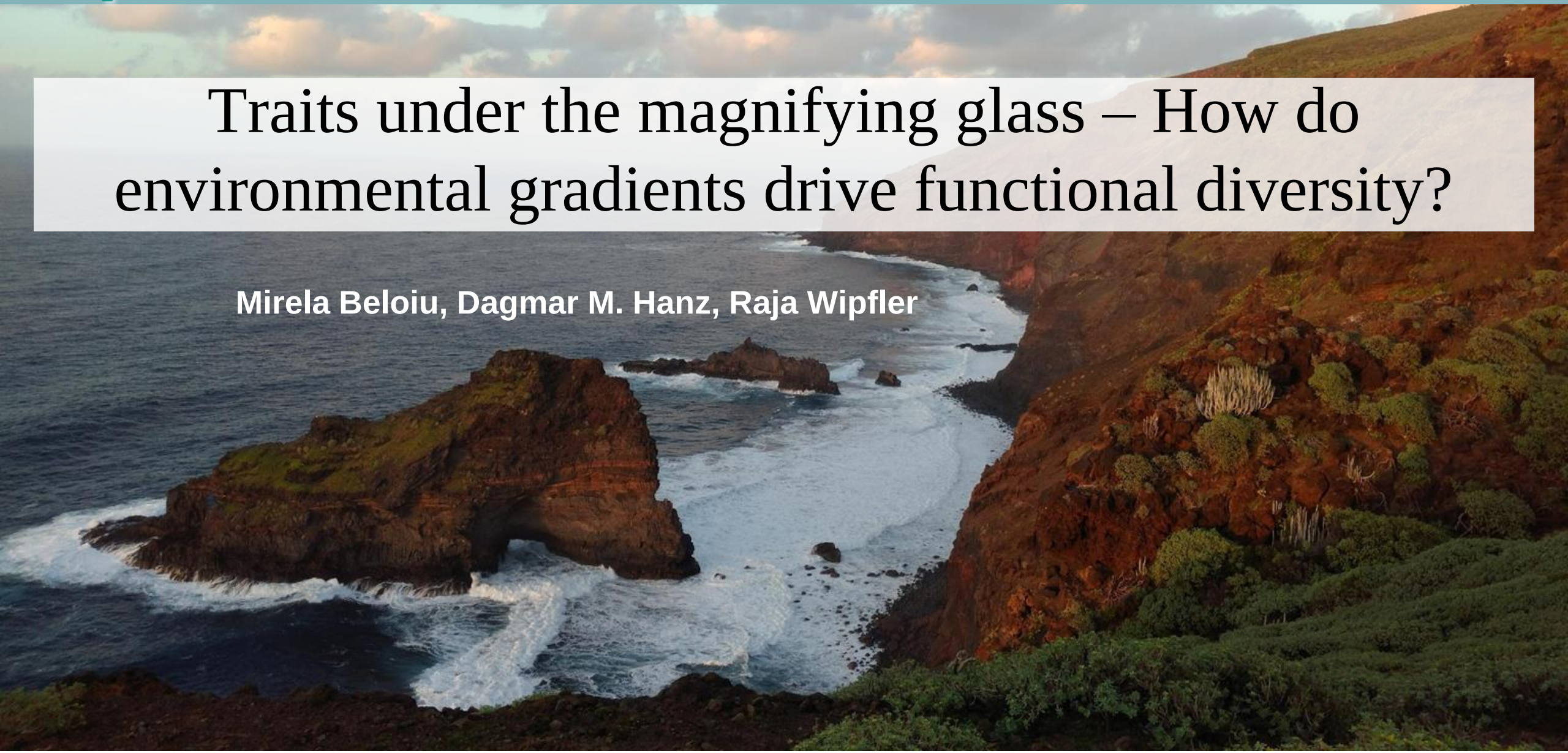
Traits under the magnifying glass – How do environmental gradients drive functional diversity?

Mirela Beloiu, Dagmar M. Hanz, Raja Wipfler



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Functional traits

- **Functional traits**

are characteristics of organisms that affect individual fitness by regulating growth, reproduction or survival [1]

Functional trait variability is essential for biological systems stability as a greater variation of functional traits are buffering ecosystems against changing conditions.

[1]Hillebrand & Matthiessen 2009, *Ecology Letters*
[2] Tilman 2001, *Encyclopedia of biodiversity*

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Functional traits

- **Intraspecific trait variability** is often neglected in diversity calculations
  - Important effects of intraspecfic trait variability on community assembly, habitat selection and ecosytsem functioning[1]

- Trait responses to environment can result from both changes in species composition (species turnover) and intraspecific trait response to environment

[1]Cornwell & Ackerly (2009) *Ecological Monographs*; Gross et al. (2009) *Functional Ecology*; Thuiller et al. (2009) *Biology Letters*

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Functional traits

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Functional trait variability

- is a response to environmental conditions
- can result from both changes in species composition (species turnover) and intraspecific trait response to environment

Interspecific trait variability

Intraspecific trait variability

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Background

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What is driving...

from here...

Functional traits

...to here

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Hypotheses

(1) Trait variability increases with mean annual precipitation

(1) Trait variability decreases with soil pH

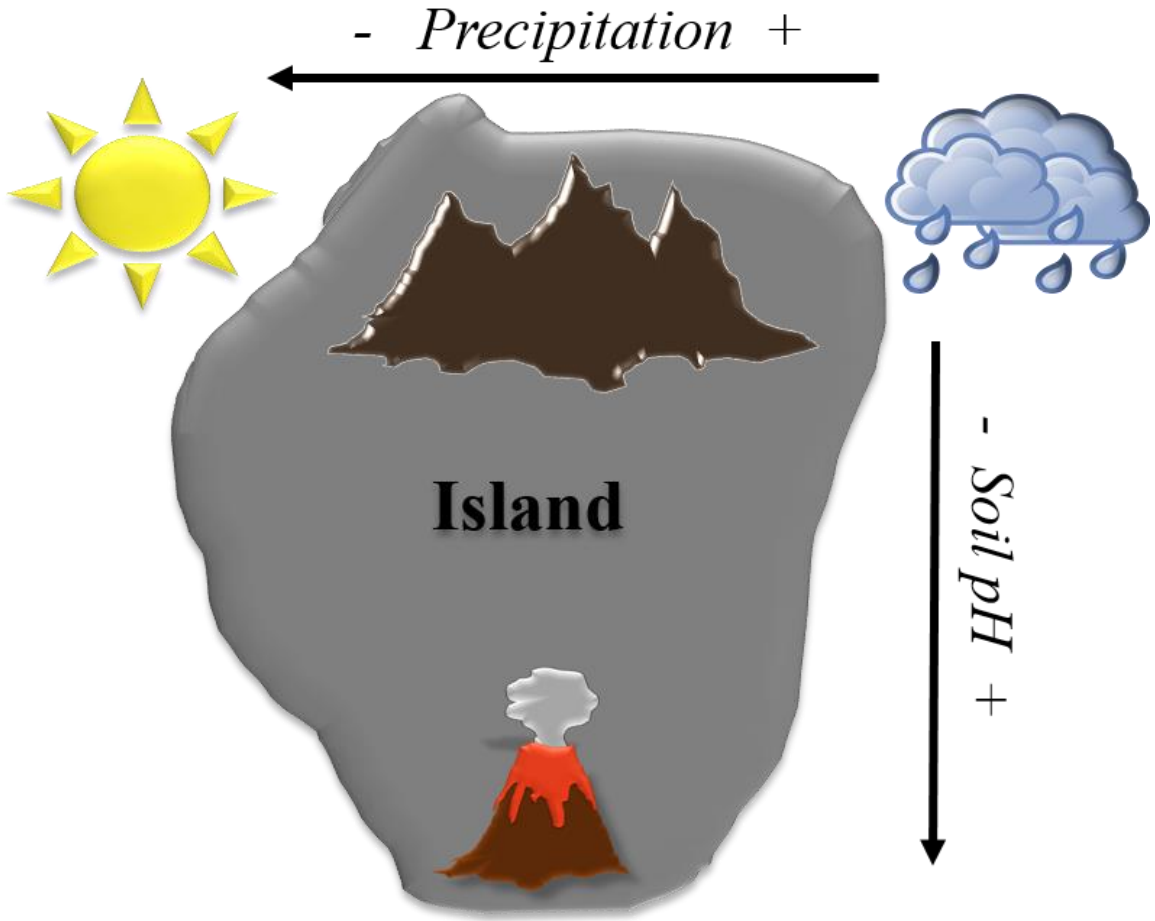

Figure 1. Oceanic islands provide a high variability in precipitation and soil pH across short geographic distances. Due to weathering soil pH decreases from young to old volcanic soil.

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Plot design: La Palma

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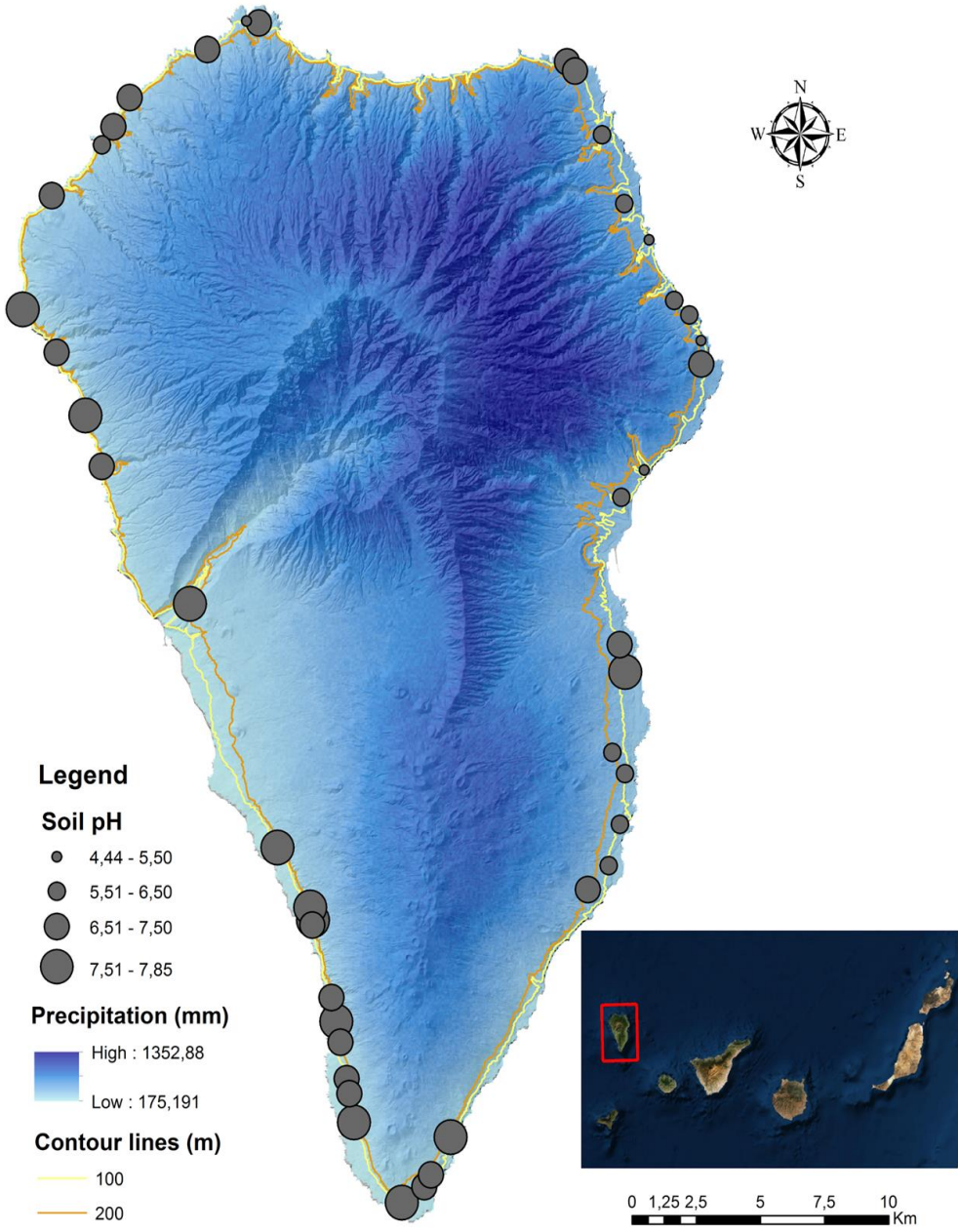
1) 44 study plots along the entire coast of La Palma

1) 7x7 m non-disturbed plots located between altitude of 100-200 m (± 10 m), at a minimum distance of 1 km (± 300 m)

1) All succulent species and all perennial species with height above 15 cm or a woody stem

1) Trait information for 1223 plant individuals out of 43 species

1) One soil sample was collected for each plot



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Functional traits

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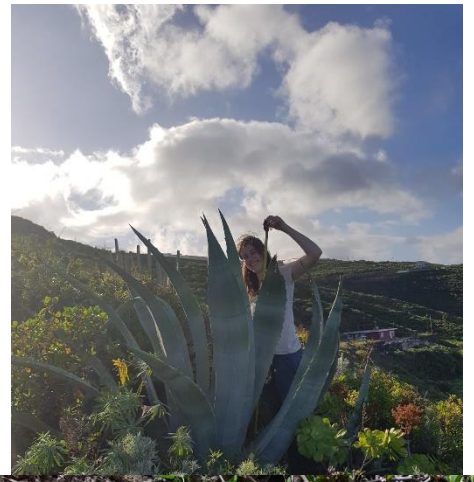
- Max. plant height
  - Ability to pre-empt light resources and disperse diaspores
  - Longevity
- Max. leaf area
  - Important consequences for leaf energy and water balance
  - Light interception & penetration to lower canopy layers [1]
- Max. leaf thickness
  - Water retention
- Leaf brightness
  - Nutrient uptake



[1] Parkhurst and Loucks 1972
[2] Pysek & Ricardson 2007; Thuiller et al. 2006

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Functional trait variability

- Principal Component Analysis (PCA)

  -to determine the general patterns and relationships between all plant traits and environmental gradients

- Partitioning community diversity into1
  - ‚between-species FD' (extent of trait dissimilarity in a community because of differentiation between coexisting species)
  - ‚within-species FD' (extent of trait dissimilarity in a community because of intraspecific trait variability)
- Decomposition of the quadratic entropy diversity

$$\text{Interspecific diversity} = \sum_{i=1}^{Nsp} \sum_{j=1}^{Nsp} p_i p_j \frac{d_{ij}^2}{2}$$

$$\text{Intraspecific diversity} = \sum_{i=1}^{Nsp} p_i \sum_{ai=1}^{Nind} \sum_{bi=1}^{Nind} \frac{1}{Nind_i} \frac{1}{Nind_i} \frac{d_{ab_i}^2}{2}$$

1Pavoine & Dolédec 2005; Rao 2010

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Results & Discussions

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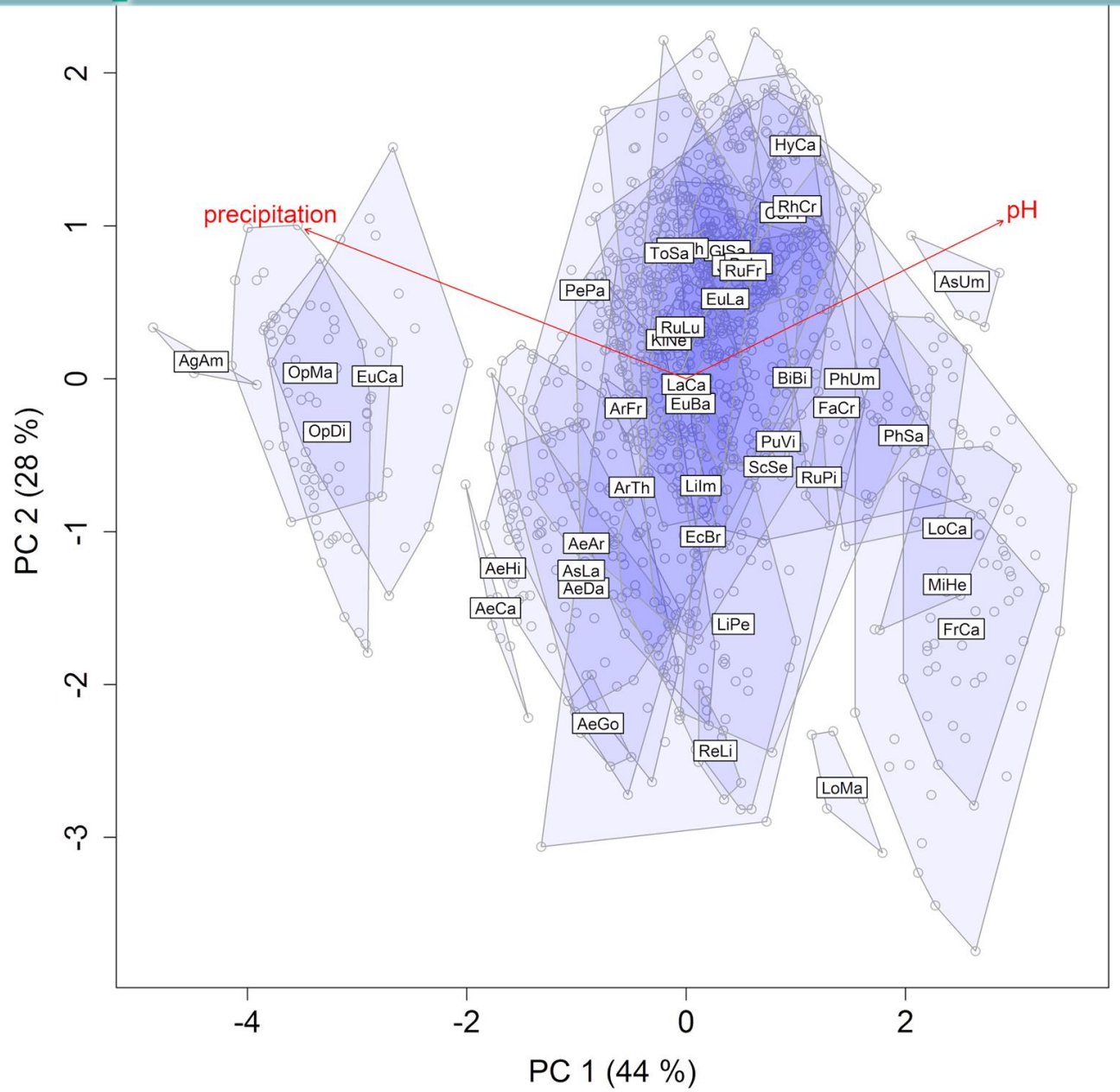

- Correlation with first PC axis
  - Precipitation (cor = 0.96)
  - pH (cor = -0.94)

- Species with greater leaf thickness, leaf brightness and leaf area in wetter habitats
- Species with lesser leaf thickness, leaf brightness and leaf area in more basic habitats
- Intraspecific variability along second PC axis

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Results & Discussions

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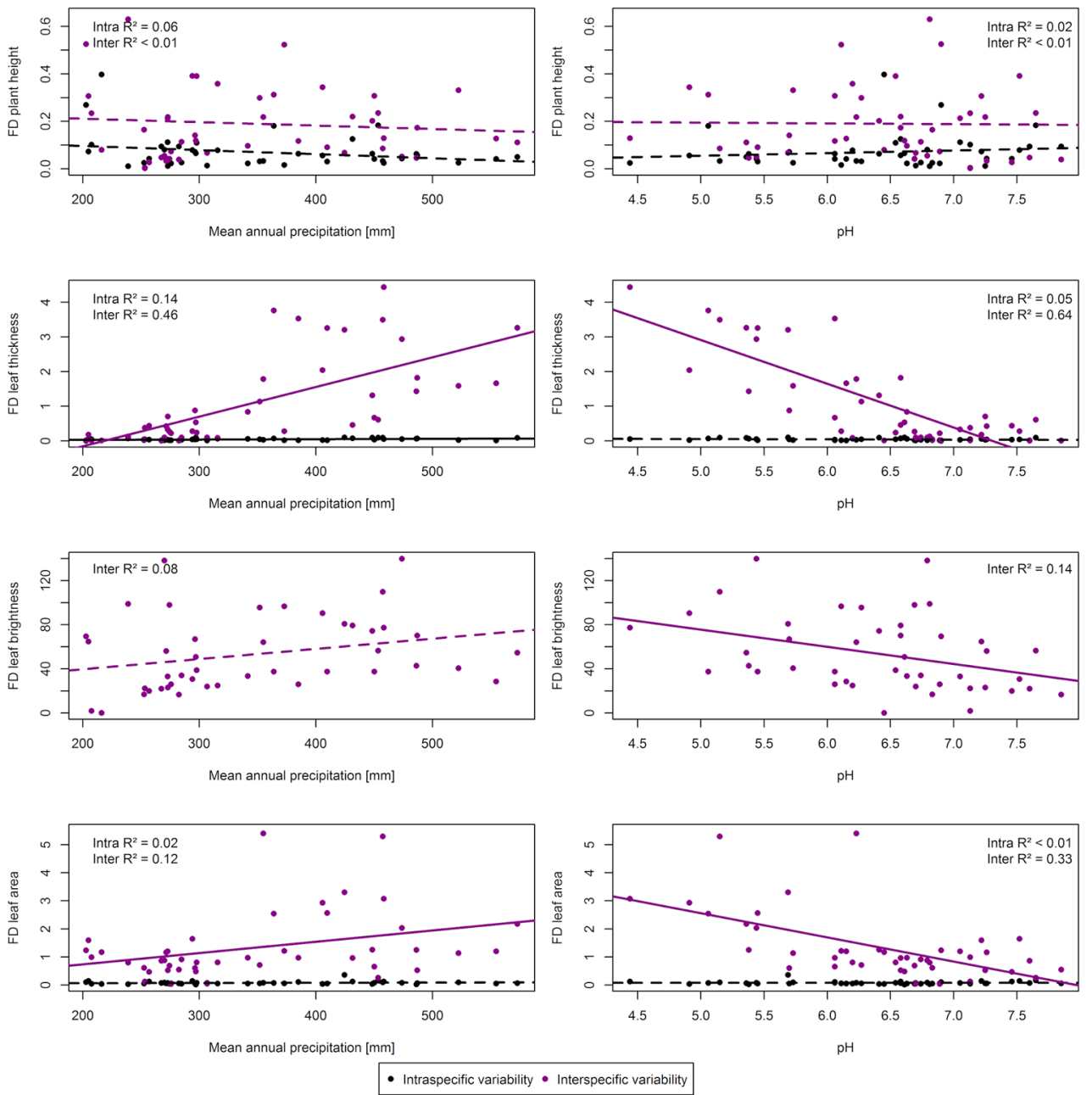
- Effect of mean annual precipitation and pH on intra- and interspecific functional diversity (by trait) at a community level show divergent patterns.



- Intraspecific variability
- Interspecific variability

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Conclusion

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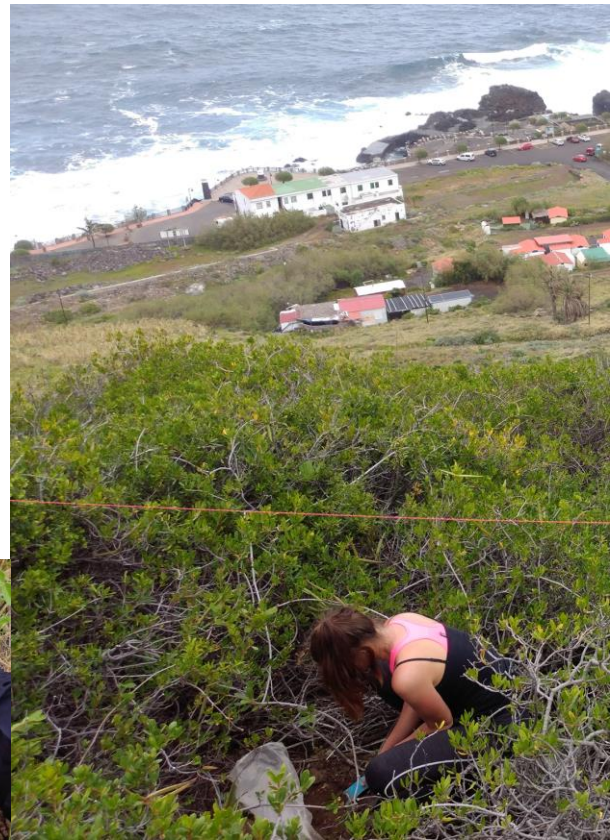
- Precipitation and pH are important drivers for leaf area, leaf thickness and leaf brightness but not for plant height
- This study offers the possibility to transfer the applied methods and acquired knowledge to other coastal systems.

❖ ArcGIS and R Studio or R-ArcGIS Bridge:

- Preparation of the plot design e.g. Slope, GPS points, grid
- Good visualization
- Analysis of raster data, e.g. Precipitation, temperature
- Possibility to perform static analyzes e.g. significance test



- Further analyses:

•Include null models to test for random patterns

•Analyse soil nitrogen and phosphorus

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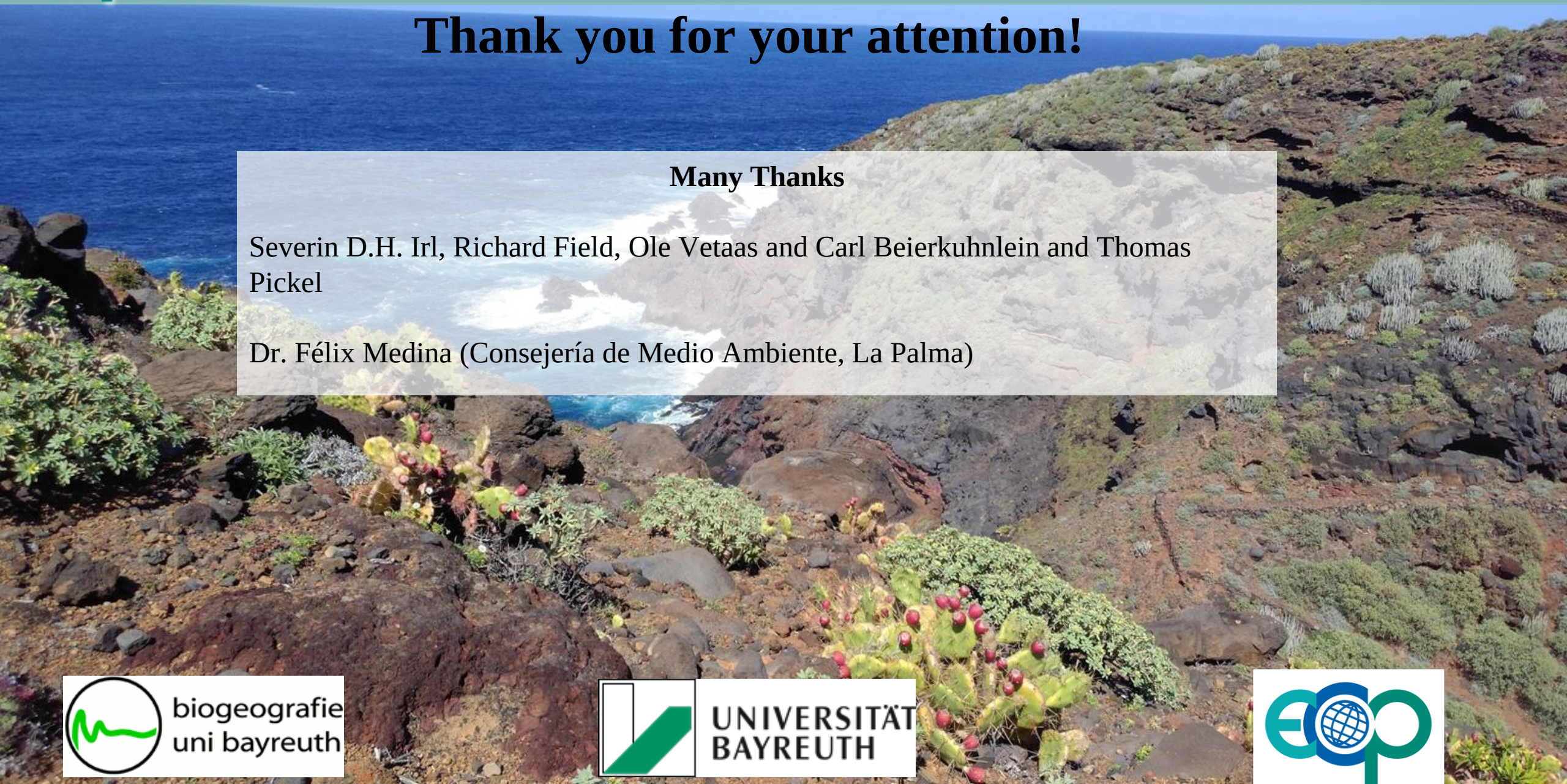
Thank you for your attention!

Many Thanks

Severin D.H. Irl, Richard Field, Ole Vetaas and Carl Beierkuhnlein and Thomas Pickel

Dr. Félix Medina (Consejería de Medio Ambiente, La Palma)



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